Universidade Nova de Lisboa
Escola Nacional de Saúde Pública

18º Curso de Mestrado em Saúde Pública 2015-2017

# Saturated fat, sodium and sugar in selected food items: A comparison across six European countries

**Jennifer Marie Tretter Ferreira**

**September, 2017**

**“An ounce of prevention is worth a pound of cure”**

**Benjamin Franklin**

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# Saturated fat, sodium and sugar in selected food items: A comparison across six European countries

Dissertation submitted to meet the requisites required to obtain a Master's Degree in Public Health, carried out under the scientific guidance of
Dr. Carla Nunes and Dr. Maria Graça Dias.

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This thesis is dedicated to:
Edgar for always supporting my goals and life ambitions
André and Daniel, my two continual motivations to pursue the best in life
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Mom and Dad for the constant moral and monetary support throughout my life and this process

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# EXPLANATION OF ACRONYMS

| | |
|---|---|
| **BC** | Brined cheese |
| **CRD** | Chronic respiratory diseases |
| **CVD** | Cardiovascular diseases |
| **DALY** | Daily adjusted life years |
| **EFSA** | European Food Safety Authority |
| **EU** | European Union |
| **EuroFIR** | European Food Information Resource |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FCT** | Food composition tables |
| **FCDB** | Food composition database |
| **FoP** | Front of package labelling system |
| **FPS** | Flake, popped and similar (breakfast cereal category) |
| **FSA** | Food Standard´s Agency (from the United Kingdom) |
| **FUC** | Fresh uncured cheese |
| **HBS** | Household budget survey |
| **I$** | International dollar |
| **INFOODS** | International Network of Food Data Systems |
| **NCD** | Noncommunicable Diseases |
| **NFCS** | National Food Consumption Survey |
| **NMES** | Non-milk extrinsic sugars |
| **PCS** | Processed cheese and spreads |
| **PortFIR** | Portuguese Platform Food Information<br>*Plataforma Portuguesa de Informação Alimentar* |
| **PUFA** | Polyunsaturated fatty acids |
| **RC** | Ripened cheese |
| **RTEBC** | Ready-to-eat breakfast cereal |
| **SFA** | Saturated fatty acids/ Saturated fat |
| **SSB** | Sugar sweetened beverages |
| **WHO** | World Health Organization |

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# ABSTRACT

**Introduction**: The amount of sodium, sugar and saturated fat in foods, when consumed in excess can lead to an unhealthy diet, and ultimately, risk for Noncommunicable diseases (NCDs). The processing of food contributes to the overconsumption of these nutrients. **Objectives**: To determine the characteristics of distribution for sodium, sugar and/or saturated fat in the commonly consumed food products of cheese, bread, and ready-to-eat breakfast cereal (RTEBC) and to compare across countries. **Methods**: For the countries of Belgium, Norway, Poland, Portugal, Serbia and Sweden, a convenience sample of cheese, bread and RTEBC was gathered from each country´s national food composition table, made available through the online databases of EuroFIR´s FoodEXplorer, Matveretabellen, Nubel and PortFIR. Specific food categories were assigned to each food group using the FoodEx2 classification system, to allow for most like food product comparison. Amounts of sodium, sugar and saturated fat were registered. After descriptive statistics, Mann-Whitley U or Kruskal-Wallis tests (with multiple comparison, if necessary) were applied to determine statistical differences across countries. **Results**: For the cheese group and saturated fat, differences were observed across countries ($p<0.01$). Highest distribution levels were in Belgium, lowest in Portugal. No differences were observed for sodium in cheese as a whole across countries ($p>0.05$), however differences were observed among the *ripened cheese* category specifically ($p<0.001$). For the bread group and sodium, statistical differences were observed across countries ($p<0.001$). Lowest medians were Portugal (290 mg/100 g), Norway (316 mg/100 g) and Sweden (362 mg/100 g); highest were Belgium (498 mg/100 g) and Serbia (510 mg/100 g). In RTEBC samples and sugar, statistical differences across countries were not observed ($p=0.236$). Lowest median was Serbia (6 g/100 g); highest was Belgium (21.8 g /100 g). **Conclusion**: In general, saturated fat in cheese, sodium in *ripened cheese*, and sodium in bread are significantly different across selected countries. Further investigation is needed to determine how much these variations contribute to excess intake. Comparison of nutrient amounts in similar foods across countries provides an opportunity to explore differences in food composition, regional products, food legislation and other forms of healthy product promotion in order to benefit consumers.

**Keywords:** Noncommunicable diseases**;** saturated fat; sodium; sugar; cheese; bread; breakfast cereal

# RESUMO

**Introdução:** A quantidade de sódio, açúcar e gorduras saturadas nos alimentos, quando consumidos em excesso, pode levar a uma dieta não saudável e, em última instância, aumentar o risco de doenças não transmissíveis (DNTs). O processamento dos alimentos contribui para o excesso de consumo desses nutrientes. **Objetivos**: Determinar as características da distribuição de sódio, açúcar e/ou gorduras saturadas em produtos alimentares comumente consumidos, queijo, pão e cereais de pequeno-almoço prontos a comer (RTEBC) e comparar entre países. **Métodos**: Para os países Bélgica, Noruega, Polónia, Portugal, Sérvia e Suécia, amostras de conveniência de queijo, pão e RTEBC foram recolhidas das respetivas tabelas da composição de alimentos, disponibilizadas através das plataformas de bases de dados on-line EuroFIR (FoodEXplorer), Matveretabellen, Nubel e PortFIR. As categorias específicas de alimentos foram atribuídas a cada grupo de alimentos pelo sistema de classificação FoodEx2, para permitir comparações mais similares de produtos alimentares. Registaram os teores de sódio, açúcar e gorduras saturadas dos alimentos que constituíam as amostras. Após a estatística descritiva, os testes de Mann-Whitley-U ou Kruskal-Wallis foram aplicados (com comparação múltipla, se for necessário) para determinar as diferenças estatísticas entre os países. **Resultados**: Para o grupo do queijo e gorduras saturadas foram observadas diferenças entre os países ($p<0,01$). O nível mais elevado da distribuição foi na Bélgica, o mais baixo em Portugal. Não foram observadas diferenças ao teor de sódio no queijo em geral em todos os países ($p>0,05$), no entanto, as diferenças foram observadas especificamente na categoria de queijo curado ($p<0,001$). Para o grupo do pão e sódio, diferenças estatísticas foram observadas entre países ($p<0,001$). As medianas mais baixas foram observadas para Portugal (290 mg/100 g), Noruega (316 mg/100 g) e Suécia (362 mg/100 g); as mais elevadas foram para a Bélgica (498 mg/100 g) e para a Sérvia (510 mg/100 g). Nas amostras de RTEBC e açúcar, não foram observadas diferenças estatísticas entre países ($p=0.236$). A mediana mais baixa foi a Sérvia (6 g/ 100 g); a mais elevada foi para a Bélgica (21,8 g/100 g). **Conclusão**: Em geral, gorduras saturadas em queijo, sódio em queijo curado e sódio em pão são significativamente diferentes em países selecionados. É necessária uma investigação mais aprofundada para determinar o quanto essas variações contribuem para uma ingestão excessiva destes nutrientes nos diferentes países. A comparação dos teores destes nutrientes em alimentos similares nos diferentes países constitui uma oportunidade para explorar diferenças na composição de alimentos de diferentes produtos regionais e legislação alimentar e eventualmente melhorar e promover produtos mais saudáveis em benefício dos consumidores.

**Palavras-chave**: doenças não transmissíveis; gordura saturada; sódio; açúcar; queijo; pão; cereais de pequeno-almoço

# 1. INTRODUCTION

Noncommunicable Diseases (NCDs) are the world´s leading cause of death and highest contributor to disability adjusted life years (DALYS). In 2015, more than 39 million people died from NCDs, accounting for approximately 71% of global mortality, with a global average of 16 years that a person lives after diagnosis of a NCD. (1). If no intervention is provided, the number of deaths attributed to NCDs is anticipated to increase to 55 million deaths by 2030 (2).

The World Health Organization (WHO) addressed concern of NCD escalation in 2011 with the formation of "The High-level Meeting of the General Assembly on the Prevention and Control of Noncommunicable Diseases". There officials discussed NCD prevention and control tactics, focusing on developing countries (3). This meeting led to the formation of the WHO´s Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013-2020, to operationalize the General Assembly´s commitments.

The action plan focuses on four types on NCDs: cardiovascular diseases (CVD), cancer, chronic respiratory diseases (CRD), and diabetes, as these four make the largest contribution to morbidity and mortality. The plan further focuses on forms of NCD prevention through accentuation of principal risk factors, which include tobacco use, unhealthy diet, physical inactivity, and alcohol abuse. There are nine global targets for NCDs. Four of the nine goals, have the potential to be directly influenced by diet.

- A 25% relative reduction in risk of premature mortality from cardiovascular diseases, cancer, diabetes, or chronic respiratory diseases.
- A 30% relative reduction in mean population intake of salt/sodium.
- A 25% relative reduction in the prevalence of raised blood pressure, according to national circumstances.
- Halt in the rise in diabetes and obesity.

We know that NCDs are influenced by diet. The amount of sugar, sodium, saturated fat and trans fatty acids in foods, when consumed in excess may contribute to an unhealthy diet, and ultimately, risk for NCDs (2). Based on available data, three out of the four of these nutritional markers will be addressed and compared in this study.

Some foods contribute to saturated fat, sodium or sugar in the diet more than other foods. Contributions of a given food item may vary within a given population depending on general individual preferences, social environment (family, friends, peers, culture, etc), physical environment factors (such as food markets) and macro-level environments such as government policy and legislation, or other factors within the ecological framework influencing what people eat (4).

There are foods recommended as a part of a healthy diet that may be found to contribute to an overall excessive intake saturated fat, sodium or sugar. Cheese, for example, is rich in calcium and other vitamins and minerals, but considered a high saturated fat and sodium food item (5). Bread, on the other hand, is not typically high in sodium, but throughout many populations has been found to be one of the leading contributors of sodium intake due to quantity of consumption (6). Breakfast cereal is highly regarded as a nutritious food choice, providing an excellent source of a variety of vitamins, minerals and dietary fiber; however, its intake is also associated with a high sugar consumption (7,8).

This study will explore differences in levels of saturated fat and sodium in cheese, sodium in bread, and sugar in breakfast cereal food items across six European countries. Comparisons will also be made with recommended daily saturated fat, sodium or sugar (SSS) levels and “healthy standards” tools. Application of each food item’s potential contribution to total SSS levels for each country will be estimated. With this information, a characterization of current levels of SSS in cheese, bread and breakfast cereal can be made with a better understanding of how each country’s food items may affect daily intake of SSS. Differences found among countries may provide evidence for product improvement and help direct areas of further study.

In public health, it is our goal to ensure that equal opportunities and resources are available to promote and enable healthy choices in order for all people to achieve full health potential (Ottawa Charter of Health, 1986). This concept is applicable to the availability of healthier food options; providing food products with lower levels of sodium, sugar and saturated fat (as well as trans fatty acids) where feasible.

The work presented in this thesis was developed within the framework of the activities of the Department of Food and Nutrition of the National Institute of Health Dr. Ricardo Jorge (INSA), a Collaborating Center of the World Health Organization for Nutrition and Childhood Obesity.

# 2. LITERATURE REVIEW

The literature review consists of two segments. The first will cover the health aspects and implications of sodium, sugar and saturated fat; each by definition, NCD risk associations and current recommended intake. The second segment will explore literature specifically on three separate food items: bread, cheese and ready-to-eat breakfast cereal, as they are identified as three staple foods contributing to higher intakes of either sodium, saturated fat or sugar. Different tools used to measure and compare healthy choices among each of these food items will also be reviewed.

## 2.1 Health aspects of dietary saturated fat, sodium and sugar

### 2.1.1 Saturated Fat

**Definition**

Saturated fat, also referred to as saturated fatty acid (SFA) is “a fatty acid in which all of the carbon atoms in the hydrocarbon chain are joined by single bonds” (9). SFAs are solid at room temperature, and in the diet are found chiefly in animal food products. Some plant food sources include coconut, palm and palm kernel oils.

**Saturated fat intake needs and recommendations**

The WHO and the Food and Agriculture Organization of the United Nations (FAO) both support lowering the risk of NCDs in recommending the reduction of saturated fats to less than 10% and trans fatty acids to less than 1% of total caloric intake. They further recommend replacing both of these fats with unsaturated fats, more specifically omega-3 and omega-6 polyunsaturated fatty acids (PUFA) (10,11). The European Food Safety Authority (EFSA) recommends that intakes of SFA “should be as low as possible within the context of a nutritionally adequate diet” (12, p52) per previously stated associated health risks. The EFSA does not have a set Population Reference Intake (PRI), Average Requirement (AR), Lower Threshold Intake (LTI), nor Adequate Intake (AI) for SFA, as SFAs are synthesized in the body and therefore not required via dietary intake (12).

### Saturated fat and Noncommunicable diseases

The FAO released a “Report of an expert consultation” on the topic of fatty acids and human nutrition in 2010. Included in it were several conclusions on the harmful effects of dietary saturated fatty acid intake in excess. Among these conclusions, it was stated “there is convincing evidence that replacing SFA with PUFA decreases the risk of CHD” and “there is a possible positive relationship between SFA intake and increased risk of diabetes” (11, p14). The conclusion of replacing SFA´s with PUFA´s to lower CHD risk and associated CHD risk markers is supported by several studies referenced in the report itself, as well as in a more recent systematic review (13) and an 11 cohort study analysis (14). Another recent review including 15 randomized control trials with over 59,000 participants had similar findings, concluding that a reduction of SFA intake led to a 17% reduction in CVD risk, but no effects on mortality. Best results were observed when replacing SFA with PUFA, as replacement with carbohydrates and protein did not yield benefits. An association between greater reductions of SFA with a greater reduction in serum cholesterol was also concluded. These beneficial results were observed in both healthy and at risk participants (15). The evidence for SFA intake and increased risk of diabetes continues to be supported in other studies, with more specific indications on SFA´s role in insulin insensitivity and overall risk for diabetes (16).

## 2.1.2 Sodium

### Definition (Salt vs Sodium)

Salt (halite) is a mineral made up of approximately 40% sodium and 60% chloride, each having specific roles in the body. Most foods in their natural form have a small amount of sodium in them, but in many counties, the majority of dietary sodium comes from processed foods with added salt such as ready meals, processed meats, cheeses and salty snacks, or from foods consumed frequently in large amounts, such as bread. In European diets it is estimated that 75% of sodium intake comes from processed or restaurant-prepared foods, typically in the form of salt, and 10–12% is from the sodium naturally in foods (17). Throughout this paper, sodium and salt may be referred to interchangeably; it is the sodium portion that is of concern for excessive intake and possible health consequences. A common conversion of sodium to salt is “sodium (mg) x 2.5/1000 = salt in grams”. The official conversion for salt to sodium is “1 gram salt (NaCl) = 393.4 mg Na = 17,1 mmol Na” (18).

### Sodium needs and recommendations

Sodium has several functions in the body including water and electrolyte balance, maintaining plasma volume, and nerve and muscle function. Sodium is also functional in food items, most notably to add flavor, and as a preservative to give food products a longer shelf-life, to enhance color and/or to enhance texture (19). In normal healthy adults, physiological requirement for sodium is less than 500 mg per day (20), other sources cite an even lower estimate of 200 mg of sodium (0.5 g salt) per day (21).

The WHO recommends that sodium intake be reduced to less than 2 g per day, or 5 g of salt per day for persons 16 years of age or older (22). In 2010, the estimated mean level of global sodium consumption was 3.95 g per day, and regional mean levels ranged from 2.18 to 5.51 g per day (23). In Europe, estimated daily intake is approximately 8–11 g of Salt (24) or 3150-4330 mg of sodium per day.

### Sodium and Noncommunicable diseases

Cardiovascular diseases (CVDs) account for 31% of all deaths worldwide, making them the leading cause of death globally (2). Hypertension is one of several risk factors for the underlying pathological process of atherosclerosis, which accounts for a majority of the deadly CVD´s (coronary artery disease CAD, cerebrovascular disease, and diseases of the aorta and arteries) (25).The link between sodium and CVD is evident based on the overwhelming evidence of sodium´s effect on blood pressure and the risk of high blood pressure and CVD (26).

The first suggested associations (19) between high dietary salt intake and increases in blood pressure were derived from a 1904 study by Ambard and Beaujard (27). Since then, repetition of these findings have occurred in several renowned studies, most notably the 1988-INTERSALT Cooperative Research (28), 1992-The Trials of HTN Prevention Collaborative Research Group (29), and the 2001-DASH-Sodium Collaborative Research Group (30). More recent studies continue to repeat the association between decreasing dietary salt and lowering blood pressure (31–33) the results noted in these studies, among several others, support recommendations for salt reduction, which in turn lower blood pressure and thereby reduce instance of CVD (34), risk of stroke, stroke mortality, and coronary heart disease mortality (35). There are studies contradicting the findings on CVD mortality (27), but this may be due to confounding factors. Nonetheless, the evidence of adverse effects of sodium in relation to vascular disease is profound (26). Consensus remains, that even though there is an intricate web of factors influencing high blood pressure and other CVDs, we cannot dismiss the overwhelming evidence of sodium´s contribution (34,35).

It is estimated globally, that one in every 10 deaths from cardiovascular disease that occurred in 2010, were attributed to sodium consumption above the reference level of 2.0 g per day, accounting for 1.65 million deaths (23). When sodium is less than 2 g per day, it was found that blood pressure could be reduced by an average of 3.47 mmHg systolic and 1.81 mmHG diastolic (35). Furthermore, reducing salt intake to less than 5 g (2 g sodium) per day is estimated to reduce the risk of stroke by 23% and the general rate of cardiovascular disease by 17% (24).

A recent systematic review compared cost effectiveness of a national supported policy intervention to reduce sodium consumption by 10% over 10 years in Western Europe. The intervention program included acts of a public health campaign targeting consumer knowledge and choices, government supported industry agreements to reduce sodium in processed foods to specific targets, and government monitoring of industry compliance. Costs were estimated at 447 International dollars (I$)* per daily adjusted life years (DALY), and globally I$465/DALY (36). The review noted results were advantageous in comparison to other types of program interventions. Pharmacologic interventions to reduce cardiovascular disease in high income countries have much higher estimated cost effectiveness ratios, an estimated $21,000/DALY or more for primary prevention with statin drugs and $6,000/DALY or more for secondary prevention with beta blockers (37,38).

### 2.1.3 Sugar

**Definitions (Sugar vs Free Sugar)**

There are no standardized definitions for added sugars, free sugars and total sugars (39), the FAO defines the term “sugar” as all monosaccharides and disaccharides present in food (40). Common monosaccharides in food include fructose, glucose and galactose. Common disaccharides in food include sucrose, lactose and maltose.



*One I$ is defined as the funds needed to purchase the same amounts of goods or services in any given country as one US$ would purchase in the US

The terms “added sugars” and “free sugars” appear interchangeably in literature (39,41). Free sugars defined by the WHO “include monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates” (42). This definition is similar to the term “non-milk extrinsic sugars” (NMES) once used by the United Kingdom. In 2015, the UK’s Scientific Advisory Committee on Nutrition (SACN) recommended to replace this term with “free sugars”, as the only notable difference between the two is that the NMES includes 50% of the fruit sugars from stewed, dried or canned fruit (43).

### The Many Forms of Added or Free Sugars

Sugar is naturally occurring in milk and plant foods -mainly fruits. Food labels in the European Union are required to list the total amount of sugar grams, but do not need to distinguish the amount of added sugar from the total sugar amount. This poses difficulty in detecting added sugar amounts, none-the-less, there is no chemical differences between added sugars and naturally occurring sugars, they go through the same digestion process, and have the same caloric value (44).

Added sugar is classified as a nutritive sweetener or caloric sweetener. Aside from sugar itself, there are many forms including (but not exclusive to): agave nectar, agave syrup, brown sugar, cane crystals, cane sugar, corn sweeter, corn syrup, corn sugar, crystalline fructose, dextrose, evaporated cane juice, fructose, fruit juice concentrates, glucose, high-fructose corn syrup, high-fructose glucose syrup, honey, invert sugar, isoglucose, levulose, malt syrup, maple syrup, maltose, molasses, raw sugar, sucrose, and syrup (45). All have different forms of processing and may be used to enhance sweetness of a product, improve texture, and/or increase a food product´s shelf life.

### Sugar Alcohols or Polyols as a Source of Free (Added) Sugars

Polyols are commonly used as a sweetener in many food products, they are “an alcohol produced by the reduction of an aldehyde or ketone of a sugar” (46). The result is a sweet tasting substance that is incompletely absorbed by the body, resulting in the absorption of less calories (47). Polyols contribute zero to three calories per gram, whereas sugar itself contributes four calories per gram, presenting an advantage for calorie reduction in foodstuff. Another advantage of polyols is that unlike sugar itself, they do not provoke tooth decay, as they do not feed oral bacteria (48).

Polyols are considered “food additives” and are assessed for their safety by the Joint WHO/FAO Expert committee on a worldwide level, and by the EFSA on a European level. They are regulated by the European Parliament and the Council on food additives under Commission Regulation (EU) No 1130/2011. Polyols approved for use in foodstuffs include: glycerol, sorbitol, mannitol, isomalt, maltitol, lactitol, xylitol and erythritol (49).

### Sugar recommendations

There is not a general recommendation for total sugar intake levels (50), however general guidelines are provided. In the proposal by the European Commission for the provision of food information to consumers, the labelling reference intakes for energy and nutrients were proposed to include a percentage of recommended daily adult intakes to allow for a more practical application for consumers. As a reference point, sugar was given an upper limit value of 90 g per day (18% of energy intake), based off of a 2000 level calorie diet (51). The EFSA addressed this proposal and agreed that the proposed value is a suitable reference point as it “is at the lower end of the range of average intakes of total sugars in adults in EU countries” (50, p3) which averaged 17-26% of total energy intake (50).

For free sugars the WHO recommends to reduce intakes to less than 10% of total energy intake for both adults and children (42). The EFSA found a recommendation such as this compatible with the proposed label reference intake of 90 g per day total sugars as estimates of indigenous sugar (sugars occurring naturally in milk and plant food) intake from the recommended amounts of fruits, vegetables, cereals and dairy are estimated to be around 45 g per day. If the remaining 45 g (out of 90 g total sugar) came from added sugar, this would yield 9% of total energy intake in a 2000 level calorie diet (50). In addition, the WHO recommends that sugar levels should not be increased in countries with a low intake of free sugars, as higher intakes of free sugars may harm nutrient quality of diets by providing a source of energy without other essential nutrients (42).

### Sugar and Noncommunicable diseases

As free sugars are “empty calories”, in that they provide no further nutritional benefits (such as vitamins, minerals or phytochemicals) aside from caloric value, their increase in consumption is of concern for both elevating total caloric intake and decreasing the intake of nutrient dense foods. These factors contribute to an overall unbalanced diet, weight gain and an elevated risk of NCDs (42,52).

Evidence of a positive association between increased sugar consumption and increase weight has been demonstrated in studies (53), but in comparing among studies that replace the caloric content of sugar with different macronutrients, no significant differences of weight change were observed. This suggests that the change in weight that occurs from consuming more sugar may be related to an over consumption of calories rather than an actual physiological response to sugar itself (53). However, there is no argument that excessive intake of sugars is a substantial promoting factor to weight gain (42,54,55), in particular free or added sugars (56,57). Overweight and obesity are among several risk factors for the development of NCDs, in particular type 2 diabetes and CVD. Actions directed towards reducing the over consumption of calories leading to overweight and obesity, are therefore likely to reduce type 2 diabetes and CVD risk and their associated complications (42).

Most research concerning the relationship between the over consumption of sugars and disease focus on the consumption of sugar sweetened beverages (SSBs), as they are a leading source of dietary sugar in many countries. In many European countries, SSBs are the second highest contributors to overall sugar intake, contributing 8-33% of total sugar intake; sweet products (i.e. cakes, cookies, chocolate, syrups, ice cream, etc) contribute the most at 21-38% (58). Increased intake of SSBs are associated with both an increased risks for type 2 diabetes and its associated risk factors, namely obesity and metabolic syndrome (59–61).

Excessive sugar intake has been associated to increased risk markers of CVD including lower high-density lipoprotein cholesterol levels (HDL-C) and elevated triglycerides, and increased triglyceride to HDL-C ratios (62,63) as well as increased blood pressure, low-density lipoprotein cholesterol and total cholesterol (63). Findings from a recent observational study showed that regardless of diet quality, persons with a higher percentage (17-21%) of calories from added sugar had a 38% higher risk of CVD mortality than those with lower added sugar intakes (8% average) (64).

Although not of the top four NCDs, in industrialized countries, dental caries consume an estimated 5-10% of the health-care budget (42). Free sugars have been identified as the most important risk factor to dental caries (42,65,66).

## 2.2 Staple foods contributing to increased saturated fat, sodium or sugar consumption

This segment will explore cheese, bread and ready-to-eat breakfast cereal each for their nutritional importance and contribution to saturated fat, sodium or sugar intake.

### 2.2.1 Cheese

**Nutritional importance**

Cheese provides an importance source of proteins and contains all of the amino acids except methionine and cysteine. Most cheese is lactose free, with the exception of fresh and some soft cheeses. It is a rich source of calcium, phosphorus, potassium, zinc and magnesium (67).

**Cheese and saturated fat**

The content of fat in cheese varies from 20 to 35% of the dry mass (67); the cream portion of the milk is the only fat source for all natural cheese. Variation of fat percentage occur by adjustments in the cheese´s casein to fat ratio. This is accomplished by separating skim and cream portions and recombining in the desired proportions or by the addition of cream or nonfat solids to milk (5). Saturated fat content makes up approximately 60% of total fat (600 g $\cdot kg^{-1}$ fat of saturated fatty acids). Trans fatty acids are found naturally in cheese and vary from 3.83 to 7.35% of total fat (38.3 – 73.5 g$\cdot kg^{-1}$ fat of trans fatty acid) (67).

**Cheese and sodium**

Cheese is also high in sodium, typically ranging 80 - 460 mg (4-23% of WHO's recommended daily sodium limit), averaging 310 mg sodium (16% of WHO's daily limit) (5) per 50-g serving, depending on cheese type. Sodium in cheese is necessary to improve texture, enhance taste and aroma, develop microflora, provide consistency and structure, ripen and control moisture, and preserve against pathogenic and spoilage bacteria. The amount of salt necessity as it pertains to quality of product have been studied for several cheese types. Most cheeses have a range of acceptable absolute salt content that does not hinder the quality of product. For example, in specific types of cheeses produced in Switzerland (Tilsit, Sbrinz, Reblochon, Camembert, etc) many have ranges of acceptability varying from 2 to 4 g of salt differences per kilogram of cheese

(68). This demonstrates reduction possibilities within these specific types of cheeses, while not compromising safety, flavor or other quality aspects. It is estimated that a reduction of salt from 10 to 25% is not noticeable by consumers. Salt substitutes, such as potassium chloride, can also be used to help lower sodium amounts in cheese (69).

#### Cheese and NCD associations

Dairy products have been studied for their associations with NCDs, in particular CVD. Studies have shown either favorable or neutral associations with cheese consumption and CVD risk (70). Studies separating cheese into low-fat, regular and high-fat varieties are needed (70) as well as lower and regular sodium classification, to fully assess associations.

### 2.2.2 Bread

#### Nutrition importance

The basic composition of bread is grain flour, water, a leavening agent (typically yeast) and salt. Grain flours in their whole form are rich in fiber, the B-vitamins: thiamine, riboflavin, niacin and pyridoxine, and in the minerals phosphorus, potassium and selenium (71). Wheat flour is the main ingredient of most breads, and is a rich source of insoluble fiber. The processing of grain (typically wheat) to yield refined flour removes the fiber and B-vitamin rich bran and the germ containing B-vitamins, some protein, minerals and healthy fats as well as phytochemicals. Refined flours are enriched to add back certain vitamins and minerals lost in the milling process. Breads containing whole grain flours are considered healthier choices as they contain natural fiber and nutrients as well as phytochemicals (phenolic acids, carotenoids, and tocopherol) (72).

#### Bread and sodium

Due to quantity of consumption, bread is a leading contributor in dietary salt intake. The average amount of sodium in bread per country across Europe presents a wide range. Reduction of sodium content is feasible without reducing quality and consumer acceptability. For adaptability, a gradual decrease in sodium content over time within a population (stealth reduction) is recommended (6). Reduction by salt substitution with potassium chloride and other mineral salts also have had favorable results (73).

Some European countries have passed legislation to reduce sodium in bread. Since 1985, bread and bread products in Belgium have a maximum salt level set at 2% of dry matter, yielding 1.2 - 1.4% salt on final product, imported bread is exempt from this regulation (74). In 2009, Portugal passed legislation setting a maximum of 0.55 g of sodium or 1.4 g salt per 100 g of bread (Lei n.º 75/2009 de 12 de Agosto). The United Kingdom set voluntary targets of 1 g of salt per 100 g bread to be obtained by 2012 (24).

### 2.2.3 Breakfast Cereal

**Nutritional importance**

The consumption of ready-to-eat breakfast cereal (RTEBC) during the breakfast meal has been associated with healthier dietary patterns, such as increased dietary fiber intake and decreased total cholesterol and fat intake (7). By cereal type, oat, barley or psyllium based cereals provide LDL and cholesterol lowering benefits; high-fiber, wheat based cereals are associated with better bowl function (75). Breakfast cereals have been noted for their high sodium content, however reviews do not associate their consumption with increase in total sodium (7,75).

**Sugar and ready-to-eat breakfast cereal**

Cereal intake as a whole is associated with higher fiber, calcium, iron, folic acid, vitamin C and zinc intakes. Higher consumption of breakfast cereal is also associated with higher total sugar intake (7,8)

# 3. BACKGROUND INFORMATION ON PRESENT STUDY

## 3.1 Country selection

A comparison study parallel to the present study was recently conducted in the Netherlands by the Centre for Nutrition, Prevention and Health Services, National Institute for Public Health and the Environment (RIVM). Using data from FoodEXplorer, food products from the countries of Finland, France, Germany, Italy, the Netherlands, Slovakia, and the United Kingdom were compared. Results to this study have not yet been published. Our study´s country selection was based on remaining European countries which could provide a variety in geographical location for comparison, and furthermore, the availability and completeness of food data.

## 3.2 Prevalence of Noncommunicable disease in each country

The importance of NCD prevention is evident by its attributes to death and quality of life factors. Table 1 provides a summary of death percentages and dying probability from NCDs in each of the studied countries.

Table 1: Summary of country specific data death percentage and dying probability from NCDs

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden |
|---|---|---|---|---|---|---|
| % of deaths attributed to NCDs (all) | 87% | 87% | 90% | 86% | 95% | 90% |
| % of dealths attributed to CVD | 30% | 33% | 49% | 32% | 54% | 41% |
| % of dealths attributed to Diabetes | 2% | 2% | 2% | 5% | 3% | 2% |
| % of deaths attributed to CRD | 7% | 6% | 4% | 6% | 4% | 4% |
| % of dealths attributed to Cancer | 27% | 27% | 26% | 28% | 23% | 25% |
| % of population bt 30-70 years old | 52.0% | 51.3% | 53.7% | 54.8% | 52.7% | 50.9% |
| Probability dying from top 4 NCDs bt ages of 30-70 | 12% | 11% | 20% | 12% | 25% | 10% |

NCD= Noncommunicable diseases

All results taken from the WHO´s Noncommunicable Diseases Country Profiles, 2014. The data from this report is "drawn from multiple sources including data provided by countries, estimates developed by WHO and the results of the global survey on assessment of national capacity for the prevention and control of NCDs which was conducted in 2013" (76, p3).

Unless stated otherwise, percent of death includes both male and female population of all ages

Top 4 NCDs are Cardiovascular disease (CVD), Diabetes, Chronic Respiratory Disease (CRD) and Cancer

Belgium, Norway, Poland, Portugal and Sweden are considered high-income countries; Serbia is considered an upper middle income country (76). Of the studied countries, Serbia and Poland present the greatest risk of dying between the ages of 30 and 70 from one of the top four NCDs; along with Sweden, they also present the highest risk of dying from NCDs in general. Across all countries, probability of death due to NCDs is high.

## 3.3 Saturated fat, sugar and sodium intakes and dietary sources from selected European countries

For four of the six European countries in this study, the most recent national food surveys were referenced. No national food surveys were available for the countries of Poland and Serbia, most recent information on diet was obtained through other available sources. Direct comparison of results of food surveys and other sources are not possible as each survey used different divisions of age groups and food groups. See Appendix A for details of each study.

### 3.3.1 Saturated fat: intake and dietary sources among selected countries, where data are available

**Belgium**

The average intake of total fat for the population aged 3 to 64 years, contributes to 36% of the energy intake; 13% from saturated fat, 0.4% from trans fatty acids, 13% from monounsaturated fatty acids, and 6% from polyunsaturated fatty acids (specifically 0.7 % from omega-3, and 5% from omega-6). The Belgium Higher Council of Health, as well as the WHO, recommends that intake of saturated fatty acids should not exceed 10% of energy intake; 90% of the population has a saturated fatty acid intake that exceeds this limit. Study results show an estimated intake of saturated fatty acids at 31 g per day (final estimate, after people who underestimated their energy intake were excluded from the analysis). Together, meat (including meat preparations and vegetarian substitutes), dairy products and "visible" fats contribute to 64% of saturated fatty acid intake. The group *produits laitiers et leurs substitutes* "dairy products and their substitutes" is the main food source contributor of saturated fatty acids, contributing 29.1% of total saturated fat intake. Next, the group of *viande, des préparations à base de viande et des produits végétariens* "meat, meat preparations and vegetarian products" contributes 20.4%, and *graisse ou propagation* "fat or spread" contributes

14.0%. The *les pâtisseries et les biscuits sucrés* “sweet pastries and biscuits” category contributes 12.6%, and the *le sucre et les confiseries* “sugar and confectionery” category contributes 7.5% (77).

**Norway**

Norway averages 34 g per day of SFA (13% of total energy) intake in their population aged 18 to 70 years. The food groups contributing the most to saturated fat are *ost,* “cheese”, *kjøtt, kjøttprodukter* “meat and meat products” *and smør, margarin, olje*, “butter, margarine and oils” (each group separately contributing around 20% of saturated fat totals). Followed by *kaker* “cakes”, *fløte, fløteprodukter* “cream and cream products”*,* and *smør, bremykt* “butter and smears”, each of these groups contributing approximately 7% of total saturated fatty acids separately (78).

**Portugal**

The average intake of saturated fat in the entire Portuguese population (ages 3 months to 84 years) contributes to 12.9% of total energy, accounting for approximately 27.4 g of SFAs per day. For the population aged 18-64 years old, SFAs contribute 12.3% of total caloric value, yielding approximately 28.5 g of SFAs per day (79).

Food groups contributing the most to SFA intake are *carnes, pescado e ovos* “meat, fish and eggs”*, productos lácteos “*dairy products” and *oleos e gorduras* “oils and fats”*.* Subgroups contributing the most to SFA intake are *carnes vermelhas* “red meats” (11%), *azeite* “olive oil” (11%) and *queijo* “cheese” (9%) (80).

**Sweden**

For the Swedish population 18-80 years old, the saturated fat average is 29.6 g per day, contributing to 13.4% of total energy intake. Food sources contributing the most to these levels SFAs are dairy products (13%), cheese (12%), margarine for sandwich spreads (10%), meat (10%), pizza, pies and pastries together (6%) (81).

### 3.3.2 Sodium: intake and dietary sources among countries of interest, where data are available

#### Belgium

Belgium´s population, ages 3-64 years, consumes an approximate 2,303 mg of sodium per day, or about 5.8 g of salt. This amount is most likely underestimated being that addition of salt to food at the table was not assessed. This estimated amount is 386 mg less sodium than the results from the 2004 Food Survey, suggesting that the country´s salt reduction campaign (launched in 2009) is having positive results on the Belgium population (82).

Four groups of food are leading contributors to sodium in the diet: 26% from *Viande, produits dérivés et végétariens* "Meat, and meat substitute (vegetarian) products", 25% from *Céréales et produits céréaliers* "Cereal and cereal products", 14% from *Produits laitiers et substituts* "Dairy products and substitutes" and 12% from *Condiments, sauces, épices* "Condiments, sauces, spices" (82).

To reduce sodium intake, Belgium has combined voluntary approaches with legislation. Salt reduction strategies stem from Federal Public Service Health since 2009. The Food Industry Federation (FEVIA) and the Federation of Commerce and Services (COMEOS) commit to salt reduction in foodstuffs on a voluntary basis (82). Belgium also has specific legislation (Royal Decree of 1985) on the maximum quantity of salt added to bread (83).

#### Norway

Average sodium intake in Norway is 3 g per day for the population aged 18 to 70 years. However, sodium values from the survey were incomplete, in that there was no systematic collection of information about adding salt during cooking or at the table.

Food groups contributing most to total sodium intake are *Kjøtt, kjøttprodukter* "Meat and meat products" (24%), *Brød* "Bread" (22%), *Divers* "Various items" (14%), *Fisk, fiskeprodukter* "Fish and fish products" (11%) and *Ost* "Cheese" (7%) (78).

Norway encourages salt reduction with the food industry through the use of a voluntary label system, the *Keyhole* (Appendix B) and maintains negotiations with the food industry for the implementation of sodium reduction practice in foodstuffs (83).

### Poland

Poland does not have a recent national survey for reference. The latest information published on sodium was obtained through the 2014 publishing of the "EU Salt Reduction Framework", where Poland´s Household Budget Survey from 2009 was referenced. This sites an average of 11.5 g per day of salt intake, translating to 4600 mg sodium per day (83).

Of the most significant sources of dietary sodium in Poland is salt added during the cooking process. Poland´s National Food and Nutrition Institute has formulated initiatives, financed by the Ministry of Health, for reducing salt consumption. They report utilizing cooperation with stakeholders for salt reduction in foodstuffs and media for consumer education to raise awareness of risks with overconsumption of salt (83).

### Portugal

The average sodium intake for the entire Portuguese population, 3 months to 84 years of age, is 2848 mg per day or 7.3 g of salt. Foods contributing the most to sodium intake are bread and toast (18%), charcuterie (8%) and soup (7%) (80).

Portugal also uses a combination of voluntary salt reduction measures and legislation to help reduce sodium in foodstuffs and overall consumption. They have commitments in product reformulation from many major food industries. Legislation was also passed in 2009 on maximum quantity of salt allowed in bread (83).

### Serbia

No actual sodium values could be retrieved from Serbia´s 2013 National Health Survey. Information covered on sodium was limited to addition of salt to already prepared food. Findings were that one in every 11 Serbian adults have the habit of adding salt to food before tasting. This habit appeared to be unchanged from their 2006 survey (84).

Serbia is not yet an EU Member State nor participating country in the EU Salt Reduction Framework. Serbia does not have a developed salt reduction strategy (85).

### Sweden

For Sweden´s population, the calculations for sodium do not include sodium from salt added at the table, as this was not assessed. The sodium from foods calculated from recipes used standardized amounts of salt/sodium as an estimate as actual amount was not known. The average sodium intake is 3118 mg, corresponding to 7.8 g of salt. The main contributors to sodium totals are meat and meat dishes (13%), bread (11%), sausage and sausage dishes (6%) and pizza, pies and pastries (6%) (81).

Sweden developed the voluntary front-of-package labelling system, the *Keyhole* (also used by Norway and Denmark), which encourages food manufactures to reduce levels of sodium, among other healthy food markers. (Appendix B lists Keyhole requirements)

### 3.3.3 Sugar: intake and dietary sources among countries of interest, where data are available

**Belgium**

Belgian population (3-64 years) has a usual monosaccharide and disaccharide intake of 109 g per day, accounting for 20% of total energy. Amounts of added sugars were not able to be distinguished from total sugar. Foods that contribute to mono and disaccharide intake were not specifically identified in the study, findings for total carbohydrate contributions were. It was found that *céréales et produits céréaliers* “cereals and cereal products” were the leading source of carbohydrate intake at 37.3%. Followed by the groups *sucre et confiseries* "sugar and confectionery", *pâtisseries et biscuits sucrés* "cakes and cookies" and *Boissons non alcoolisées* "soft drinks" estimated at 10% contribution each. The groups *fruits* "fruits", *pommes de terre et autres tubercules* "potatoes and tubers" and *produits laitiers et substituts* "dairy products and substitutes" contribute to carbohydrate intake at around 8% each (86).

**Norway**

The Norkost 3, 2010-2011, gave results of Norwegian population aged 18 to 70 years. Total sugar grams were not reported in this survey, rather average total carbohydrate consumed (240 g per day, 43-44% of total energy) and added sugars (42 g per day, 7% of total energy). Leading dietary sources of total mono and disaccharide (sugar) intakes are *saft/brus* “soda” which contributed to 29%, *Sukker, søtsaker* “sugar and sweets” 21%, *Kaker* “cakes” 15%, and *Frukt, bær* “fruits and berries” 11% (78).

**Portugal**

The Portuguese average national consumption of sugar (mono and disaccharides) for the entire population (ages 3 months to 84 years) is 94.6 g per day, accounting for 19.8% of total energy (1912 kcal). For the population aged 18-64 years, 17.3% of total energy (2089 kcal) comes from simple sugars, accounting for approximately 90 g per day (Sweet foods, soft drinks (not including nectars), cakes (including pastries), cookies and biscuits, breakfast cereals and children cereals account for 30.7% of simple sugar <*açúcares simples*> consumption (79).

**Sweden**

The Swedish population 18 to 80 years old have a monosaccharide and disaccharide combined average estimated at 88 g per day corresponding to an estimated 17.8% of total energy intake. Average intake of added sugar is 47.9 g per day, which corresponds to 9.6% of total energy intake. The main sources of the added sugar are sweetened drinks, buns, cookies and cakes, and candies and chocolates (81).

The main sources of sugar were separated by sources of monosaccharides and sources of disaccharides. The intake of monosaccharides averaged 31 g per day. Monosaccharide intake come primarily from fruits and berries (27%), juices (10%), sweet soups, desserts, purees, marmalades and jams (9%), vegetables (9%), bread (8%), and juice, soda, sport and energy drinks (5%). Average intakes of disaccharides were 57 g per day. Disaccharides come mainly from dairy products (23%), candy, sweets, desserts, purees, jams and marmalade together (13%) Fruit, cakes and juice, soft drinks, sports and energy drinks (10%) (81).

## 3.4 Selection of food items studied

Food items selected for the present study were based on their influence in dietary saturated fat, sugar and/or salt across countries. As evidenced in the review on dietary sources from each country, cheese was studied for its influence in saturated fat and salt intake; bread for its sodium; and breakfast cereal items for their sugar content. Priority was given to these food items as they are also considered highly nutritious foods (not empty calorie foods) and may be formulated to yield lower amounts of sodium, saturated fat and/or sugar.

## 3.5 Recommended intakes and consumption level of each studied food item by country

### 3.5.1 Cheese: Recommended intakes and consumption level by country

**Belgium**

Since cheese is a food with a relatively high lipid and salt content, the Belgium Food Pyramid recommends a maximum cheese intake of 20 to 40 g per day, depending on age. Persons 12-18 years old and those over the age of 60 have a maximum limit of 40 g per day. While all other age groups, from three years of age up, have an upper limit recommendation of 20 g per day (87).

Cheese consumption among the Belgium population (aged 3 to 64) is broken down as follows: 21.2% eat cheese daily; 9.3% consume cheese five to six times a week; 47.6% eat cheese an average of four times per week; 14.9% consume cheese less than once a week; and an estimated 7.1% never consume cheese. Consumption on average is 30 g of cheese per day, with a median of 27 g per day. Broken down by age group, 3-5 year-olds consume 15 g per day; 6-9 year-olds 22 g; 14-17 year-olds 25 g; 18-39 year-olds 32 g; and 40-64 year-olds consume 33 g of cheese per day (87).

**Norway**

The 2014 Norwegian guidelines on diet nutrition and physical activity recommend lean dairy products to be a part of a daily diet. It advises to limit the use of dairy products with high saturated fat such as whole milk, cream, high-fat cheese and butter; dairy product selection should focus on items with low fat, salt and low in added sugar. No specific recommended amounts for cheese are given (88).

The Norwegian average intake of cheese for the population 18-70 years old is 41 g per day. No significant differences are noted in average intake of men verses women, nor by educational level (78).

**Poland**

The Polish "Principles of healthy eating for adults" *Zasady zdrowego żywienia,* recommends a minimum of two cups of milk or milk equivalent per day. Equivalents of calcium content for one cup of milk corresponds to: one glass yogurt, kefir or buttermilk; two thin slices of cheese; curd cheese cube (300 g); two packages of cotta cheese (2 x 200 g); or two packages of homogenized cheese (2 x 150 g) (89).

The Household Budget Survey (HBS) 2015 found that in-home consumption of cheese averages 0.83 kg per month per person, curd cheese specifically is 0.43 kg/month, ripening and melted cheese is 0.4 kg/month. This is approximately 27.6 g of total cheese per day, 14.3 g from curd and 13.3 g from ripening and melted cheese specifically (90).

**Portugal**

The Portuguese *Nova Roda dos Alimentos* “New Food Wheel Guide” recommends two to three servings of dairy per day. Servings are one cup milk (250 ml), one liquid yogurt or 1.5 solid yogurts (220 g), 40 g or two thin slices of cheese, 50 g fresh cheese, or 100 g of *requeijão* “cottage cheese” (91).

Average intake of cheese for the entire Portuguese population is 17.7 g per day. The average for children 0-9 years of age is 8.7 g, 10-17 years is 16.96 g, adults 18-64 years of age is 21.33 g, and 65-84 years of age is 19.25 g (92).

**Serbia**

No national dietary guidelines were able to be obtained from Serbia.

Information from Serbia´s health survey did not provide cheese intake specifically, rather on dairy products as a whole, stating that a one-cup milk equivalent of dairy is consumed daily by 51.7% of Serbian citizens. This is an increase from 2006 where only 43.5% of Serbians consumed this amount daily (84).

**Sweden**

The 2015 National Dietary Guidelines published by the Swedish National Food Agency (Livsmedelsverket) uses Nordic nutritional recommendations to “choose low-fat unsweetened dairy products enriched with vitamin D” (93). No specific daily amounts or serving sizes are referenced.

Cheese consumption for both men and women averages 25 g per day. Most commonly consumed cheeses are hard cheeses with fat content of 20-40% (81).

### 3.5.2 Bread: Recommended intakes and consumption level by country

**Belgium**

The 2012 Belgium active food pyramid (VIGeZ) advises to consume an average 90 to 210 g (3 to 7 slices) of whole grain bread per day according to age (94).

Belgium has legislation for a maximum of 2% salt in dry matter, corresponding to 1.2-1.4% salt on final product (24). (Belgian Royal Decree of 2 September 1985)

Usual consumption of bread (and *other* bakery products such as buns, sandwiches and baguettes) among the Belgium population aged 3 to 64 years, is 104 g per day on average. The Belgian population (15 to 64 years) consumes significantly less bread (107 g per day) in 2014 than in 2004 (121 g per day), but the proportion of people who consume bread on a daily basis has increased from 46.1% in 2004 to 51% in 2014 (95).

**Norway**

General recommendations on bread come from the wholegrain section of Norway´s Food Based Dietary Guidelines. In general, consumption of whole grain products is recommended to yield 70-90 g of wholegrain flour or wholegrains per day. An example given to achieve this daily recommendation includes a suggestion of consuming 4 slices of wholegrain bread; however, other suggestions without bread are provided. Therefore no specific recommendation of daily bread in grams is given. Further recommendations are to eat wholegrain products daily, to choose grain products with high fiber and wholegrain content that are low in fat, sugar and salt content. They also advise looking for products containing the *Nøkkelhullet* “Keyhole”, and the utilization of the labelling scheme *Brødskala’n* “Bread Scale” (88).

The Keyhole is a front of the package symbol that identifies healthier alternatives within a food or product group. In order for use by manufacturers, food products must meet set requirements for various product groups relating to fiber, salt, sugar, fat and saturated fat content (96). See Appendix B for bread *Keyhole* requirements.

The Bread Scale is a labelling system comprised of four labels categorizing bread on the basis of its wholegrain, wholegrain flour and bran content. The four categories are fine (0-25% wholegrains or wholegrain flour and bran content), semi-course (25-50%), course (50-75%) and extra course bread (>75%) (97).

Norkost 3 found bread intake to average at 184 g per day; 227 and 144 g per day when divided by men and women respectively (78).

**Poland**

The Polish "Principles of healthy eating for adults" *Zasady zdrowego żywienia,* recommends to eat at least five cereal products, including bread per day, three of these servings coming from whole grains (89).

According to Poland´s Household Budget Survey from 2015, consumption of bread in the home is 3.74 kg per month; approximately 124.6 g per day (90).

**Portugal**

The Portuguese "New Food Wheel recommends 4 to 11 servings from *Cereais e derivados, tubérculos "*Cereals and derivatives, tubers". A serving of bread from this food group is 50 g for regular bread and 70 g for corn bread (91).

Portugal has legislation specifically for the maximum permissible amount of salt that is allowed in bread. Legislation (Lei n.º 75/2009 de 12 de Agosto) allows 1.4 g salt per 100 g bread, this corresponds to 14 g salt per kilogram of bread or 0.55 g sodium per 100 g bread (83).

Average consumption of bread and toasted bread is 87 g per day nationally. Further breakdown by age reveals children less than 10 years of age consume 34 g, children aged 10-17 consume 83 g, 18-64 year olds consume 105 g, and 65 to 84 year olds consume 115 g of bread and toasted bread per day (79).

**Serbia**

Serbia´s general health survey findings were focused on the percent of population that consumed refined or integral types of bread. 8.2% of the population consumed integral types of bread in 2013; this is a drop of 6.1% since the 2006 survey. Average amount of bread intake as a whole was not reported in the survey´s results (84).

#### Sweden

Sweden does not have specific recommendations on bread consumption. Their food guide tool "Find your way to eat greener, not too much and be active" advise is for wholegrain consumption, recommending 70 g per day for women and 90 g per day for men. Like Norway, it also advises to look for bread with the keyhole symbol, which indicates a product with more wholegrain and fiber and less sugar and salt (91).

The bread group included hard and soft bread, and bread from the composite dishes of burgers, falafel and kebabs. Total daily consumption of bread on average is 87 g per day. Bread is the second highest food group in its contribution to sodium, measuring at 11% (81).

### 3.5.3 Ready to eat breakfast cereal: Recommended intakes and consumption level by country

#### Belgium

Recommendations for breakfast cereals fall under general recommendations for grain products. The Belgium active food guide pyramid recommends 5-12 slices of bread or similar amount of cereal products. Full grain products, limited in added sugar, fat and salt are preferred (91).

Seventy-five percent of respondents did not eat breakfast cereal during the two-day 24-hour dietary recall. The population (aged 3 to 64) consumes significantly less breakfast cereal than bread. Usual cereal consumption for breakfast is 6 g per day, on average (95).

#### Norway

No specific recommendations on cereal amounts are given, advice comes from the same area as the bread group. Persons are advised to obtain 70-90 g of wholegrain flour or wholegrains per day and to choose grain products with high fiber and wholegrain content that are low in fat, sugar and salt content (88).

Cereal intake is not specifically identified as a category; *Kornvarer* “grain mill products” average intake across the population of 18-70 year-olds is 40 g per day; 45 for men and 35 for women (78).

**Poland**

Daily recommendations are to eat at least five cereal products "produktów zbozowych", including ready to eat breakfast cereal, three of these servings coming from whole grains (89).

Referencing HBS 2015, in-home breakfast cereal consumption is 0.13 kg per month or approximately 4.3 g per day (90).

**Portugal**

Portuguese recommendations are 4 to 11 servings from *“*Cereals and derivatives, tubers” *Cereais e derivados, tubérculos.* A serving of breakfast cereal from this group is 35 g, or approximately 5 tablespoons of cereal. Besides bread and cereal, other food items in this group include biscuit crackers, rice and pasta (serving of 35 g each, dry/before cooking), and tubers (125-g serving) such as yams, potatoes, jicama, etc (91).

Average consumption of breakfast cereals is 15 g per day at a national average. Further breakdown by age showed that children less than 10 years of age consume an average of 29 g per day; children aged 10-17 consume 26 g per day; 18-64 year-olds consume 10 g per day; and 65-84 year-olds consume 4 g of breakfast cereal per day (79).

**Serbia**

No breakfast cereal consumption information was provided through Serbia´s national health survey. Breakfast cereals are not a part of Serbia´s tradition, however in view of recent market estimates they appear to be growing in popularity. In a 2016 Euromonitor International research report on Serbia it was stated that breakfast cereals are gaining popularity for convenience and healthy alternative aspects (98).

**Sweden**

Specific recommendations are not given for breakfast cereals. General advice is provided through the country´s food based dietary guidelines in regards to choosing grain products. Its recommendation is 70 g per day of wholegrain products including breakfast cereals for women and 90 g for men. It also advises to look for breakfast cereals with the keyhole symbol, which indicates a product with more wholegrain and fiber and less sugar and salt (93).

Sweden´s breakfast cereal group “Flingor”, which translates to “flakes”, covered a wide variety of breakfast cereals and muesli. Average consumption for women is 10 g per day, 14 g for men and 12 g per day for both men and women (81).

# 4. RESEARCH QUESTION AND STUDY OBJECTIVES

## 4.1 Research question

What is the current nutritional profile concerning sodium, sugar and/or saturated fat in selected food items and categories among selected European countries? Is there a difference in these amounts across selected countries? Knowing this will allow for the direction in efforts for further investigation and research, and the exploration of why differences may exist.

## 4.2 Objectives of the Study

The goals of this study are to characterize and compare the amounts of saturated fat and sodium in cheese, sodium in bread, and sugar in ready-to-eat breakfast cereal (RTEBC) among six different European countries. Within the food items, specific categories have been defined and food items separated into each, to allow for comparisons of most similar items. To provide an estimation of the potential impact each food item may contribute to saturated fat, sodium or sugar total intake for each country, mean or median values from each food item will be compared across countries and to "healthy standards". Finally, consideration will be given to other identified contributing factors as to why differences may occur between countries.

For this, the study's first goal will be to characterize and compare sodium, sugar and/or saturated fat levels for each food item across countries.

The second goal is to confirm whether or not separation into specific categories among the food groups (i.e. bread group having two categories: leavened and unleavened) presents a statistical difference in distribution of the sodium, saturated fat and sugar levels.

The third goal is to compare how similar the food products within each specific category are when compared across countries. This information will provide a clearer picture of where the differences among countries lie and ensure that the comparison of the most similar products are being made.

The fourth goal is to gain a better understanding of how well product selection is in agreement with saturated fat, sodium or sugar standards, and estimate the potential impact of each food item to total sodium, saturated fat or sugar intake for each country, based on represented products available per country. This will be accomplished by application of results of each of the food item´s characterization, namely mean and median values.

The final goal will be to consider other influencing factors previously identified. After results for the previous goals have been obtained, information (already identified in section 3- Background information) on other identified contributing factors to sodium, sugar or saturated fat levels in each of the food items shall be considered.

# 5. MATERIAL AND METHODS

## 5.1 Study design and participants

This is a cross-sectional, multi-country exploratory study using data from a convenience sample collected from the national food composition tables (FCT) for the countries of Belgium, Norway, Poland, Portugal, Serbia and Sweden. The national FCTs were made available through online food composition databases (FCDB). For most recent and comparable data, the study utilized four separate sources, EuroFIR platform with FoodEXplorer tool (for the countries of Poland, Serbia and Sweden), Matveretabellen (Norway), Nubel (Belgium) and PortFIR (Portugal).

## 5.2 Data sources: Food composition databases

Each country typically has an established program to manage its own food composition data, with a series of guidelines in the collection and analyzation process for foods set forth by the International Network of Food Data Systems (INFOODS). The principal concern in the selection of foods for inclusion in a food composition table or database is the contribution of the foods to the diet (99).

Before beginning the data collection process, and with the assistance of EuroFIR AISBL, the responsible for each country´s FCT/FCDB was contacted to confirm the inclusion criteria for foods included in their FCT/FCDB. During these email exchanges Belgium, Norway and Portugal suggested the use of their online databases (Nubel, Matveretabellen and PortFIR, respectively), for most recent country specified data. All countries confirmed inclusion criteria was based on foods most commonly consumed. The mapping of a FCT focuses on foods that are consumed nationally in order to provide data that is applicable to consumption in each country. These FCTs and databases are updated according to the new consumption data and new foods, typically through the results of national food surveys.

Table 2 provides a summary of each country´s food composition tables and database sources, and the year in which they were published (version).

Table 2: Food composition tables, database sources and year in which published for each country

| Country | Food composition tables and databases accessed | Version |
|---|---|---|
| Belgium | Institution: Nubel<br>Database: NIMS (online)<br>Accessed via Nubel (http://www.nubel.com/) | 2017 |
| Norway | Institution: UiO,<br>Database: The Norwegian Food Composition Table, Matveretabellen<br>Accessed via Matveretabellen (http://matvaretabellen.no/) | 2016 |
| Poland | Institution: NFNI<br>Database name: Food Composition Tables<br>Accessed via EuroFIR (http://www.eurofir.org/foodexplorer) | 2005 |
| Portugal | Institution: INSA<br>Database: Tabela de Composição dos Alimentos – INSA<br>Accessed via PortFIR (http://portfir.insa.pt/foodcomp/search) | 2015 |
| Serbia | Institution: IMR<br>Database: Serbian Food and Nutrition Database (online)<br>Accessed via EuroFIR (http://www.eurofir.org/foodexplorer) | 2016 |
| Sweden | Institution: NFA<br>Database: NFA Food Composition Database (online)<br>Accessed via EuroFIR (http://www.eurofir.org/foodexplorer) | 2013 |

#### 5.2.1 EuroFIR platform with FoodEXplorer tool (Poland, Serbia and Sweden)

The European Food Information Resource (EuroFIR) Network of Excellence was set up in 2009 "to ensure sustained advocacy for food information in Europe" (100). It is an international, non-profit organization acting under Belgium law and was developed to "publish and exploit food composition information, and promote international cooperation and harmonisation of standards to improve data quality, storage and access" (100). It provides access to 28 national food composition databases through its FoodEXplorer tool. EuroFIR has offered the first standard operating procedures in food composition including the identification of relevant foods, nutrients and background information. It is cited by the WHO as a direct and primary source for national food composition databases (101).

Countries may use a variety of methods to compile food composition data, which include chemical analysis of food samples, calculation of values through yield and nutrient retention factors, or adopting values from another qualified food composition database and/or other sources such as scientific literature for analyzed values of branded food labels (100).

### 5.2.2 Matveretabellen (Norway)

The FCT and online database provide a selection of the most commonly consumed foods in Norway. It includes 1600 food items and 38 different nutrients and is an important tool used to monitor diet development. Practical work on the FCT is conducted by experts at the Food Safety Authority and the Department of Food Science, University of Oslo (102). Compilation standards are equivalent to that of EuroFIR´s.

### 5.2.3 Nubel (Belgium)

Established in 1990, Nubel is responsible for the scientific nutritional information relating to the foods that are commonly consumed in the Belgium diet. The establishment is supported by the Belgium government and has a scientific council responsible for the evaluation and validation of the data analyzed (103)**.** Nubel supplies EuroFIR with nutritional data from Belgium. Their latest data version (2017) was made available by Nubel through special request. Age of data analyzation from the 2017 version may vary between 2009 and 2017.

### 5.2.4 PortFIR (Portugal)

The PortFIR program (Portuguese Platform Food Information) was established in 2009 in response to the need to integrate food information data at a national level and was inspired by EuroFIR. It is coordinated by the Nacional Institute of Health Dr. Ricardo Jorge (INSA) and partnered with the Portuguese Association of Identification and Codification of Products (GS1 Portugal CODIPOR). Among its many roles, it is responsible for food information management with the collection, compilation, standardization and validation of data from various sources in the country (104).

The food composition table (also with online database) provided through PortFIR is a national reference document for the composition of foods consumed in Portugal, and is edited by INSA. It uses the same methods for calculation of nutrients in recipes as EuroFIR and follows energy value calculations according to Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011 (104).

## 5.3 Variables

Table 3 provides a summary of the variables referenced in this study.

Table 3: Summary of variables

| Variable | Measurement level | Label |
|---|---|---|
| Countries | Nominal | Belgium<br>Norway<br>Poland<br>Portugal<br>Serbia<br>Sweden |
| Cheese category | Nominal | Fresh uncured cheese<br>Processed cheese and spreads<br>Ripened cheese<br>Brined cheese |
| Bread category | Nominal | Leavened<br>Unleavened or flat bread |
| Ready-to-eat breakfast cereal | Nominal | Flake, Popped and similar<br>Muesli |
| Saturated fat | Scale | Saturated fat (g) |
| Sodium | Scale | Sodium (mg) |
| Sugar | Scale | Sugar (g) |

### 5.3.1 Variables measured

The three variables measured within the food samples were the nutrients sodium, sugar and saturated fat (saturated fatty acids). For sodium and saturated fat, values were directly stated in the FCDB. For sugar, the equations: "monosaccharides (g) + disaccharides (g) yields sugar (g)" and "total carbohydrate (g) – starch (g) – fiber (g) yields sugar (monosaccharides + disaccharides)" were used. These measures remained consistent across all FCDBs.

## 5.4 Collection and categorization of data

All food items were collected using the EuroFIR platform with FoodEXplorer tool, Matveretabellen, Nubel and PortFIR databases.

As each food item selected for study represented a broad range of types, the FoodEx2 classification system was used to further categorize the selected food items. FoodEx2 is a "comprehensive food classification and description system" (105) developed by the EFSA. Its purpose is to standardize food classification to facilitate data comparison from different sources and allow for more in depth data analysis. It is designed so that each specific food product may fall under only one classification grouping. Its system of classification is used in the EU Menu process framework for harmonization in food data collection and processing (105). Food items from each of the four databases used are not classified to FoodEx2 standards, as this system was initially developed for food contaminants. Due to its simplicity in comparison to other food composition codification systems, FoodEx2 was adopted by the EFSA for use in food composition data. Databases in EuroFIR platform use a classification system called LanguaL, a more complete and complex system developed in the United States. Classification through the FoodEx2 system was completed manually with information given in the title of the product, LanguaL references where available and inferences made from nutritional composition.

The overall objective of category classification of all of the food items is to provide for the fairest comparison among the most similar of products.

### 5.4.1 Collection and categorization of cheese data

**Collection of cheese data**

A general search of cheese was conducted, along with searches including all of the names of the FoodEx2 extended terms (see Appendix C) as to provide an exhaustive list of cheeses from the products available on each database, to represent each of the six countries. All cheese items where cheese remained the main product in a classifiable form of the four cheese categories were included. Cheese products were allowed to contain ingredients such as herbs, spices, or items added in small amounts for flavoring. Cheese with appeared small portions of added fruit and nuts were allowed. Cheese desserts (i.e. *fresh cheese dessert*) were excluded. For processed cheeses, items which had added meat, nuts and vegetables for flavoring were included in the study, nondairy cheese items were excluded.

**Categorization of the cheeses**

Once inclusion criteria was met for the defined cheese sample, FoodEx2 was used to help further classify each data sample into cheese types.

Under the “milk and milk products” hierarchy term, the generic term “cheese” yields five groupings of cheese terms as either core or non-specific terms. These terms include fresh uncured cheese, brined cheese, ripened cheese, processed cheese and spreads, and rind cheese. No cheese product classified as “cheese rind” appeared in any of the six counties´ databases, therefore each of the cheeses were categorized into one of the preceding four terms, and for this study´s purpose, these four terms shall be referred to as “cheese categories”. (See Appendix C for further detail of each cheese category)

FoodEx2 provided a system of classification for the cheese categories. For an extensive description of each of the specified categories, the Codex Alimentarius´ “Milk and Milk Products” compilation was referenced to help further clarify the defining terms of the cheese categories. The Codex Alimentarius is also known as the “Food Code”, its Commission is made up of a joint intergovernmental body of the FAO and WHO along with 186 Member States and one Member Organization (EU). Since 1963, Codex has strived to “create harmonized international food standards to protect the health of consumers and ensure fair trade practices” (106).

The different cheese category classifications provides a more in depth picture of each country´s breakdown of cheese products. It also provides for a fairer comparison among nutrients. For example, a brined cheese would contain more sodium than other cheeses due to their processing of being soaked in a salt brine; fresh uncured cheeses, as another example, contain more varieties of cheese that are lower in sodium and fat. However, much variation can occur depending, for example, on the fat content of milk or cream used for its confection, or whether or not the product underwent a heating process (yielding less water volume and ultimately a higher fat and sodium content). Cheeses are used differently based on their type; typical portion size consumed may also vary by cheese type.

**Fresh uncured cheese:**

Codex Alimentarius has a group of standards for “unripened cheese including fresh cheese” which they define as “cheese which is ready for consumption shortly after manufacture” (107, p76). This definition defines the word “fresh” of this study´s *“fresh uncured cheese*” category, and is in line with the extended term examples given in FoodEx2. The term “uncured” refers to cheeses that have not been preserved by salting, drying or smoking.

Most whey cheeses fit into this definition, as they are produced by either “the concentration of whey and the moulding of the concentrated product” as in ricotta cheese, or “the coagulation of whey by heat with or without the addition of acid”(107, p83). In the latter case, the final product may be obtained by either a unripened or ripened process.

The Codex Alimentarius has a separate standard for whey cheeses. As we chose to use the FoodEx2 classification system, whey cheeses were divided into a cheese category based on how they were made (whether ripened or unripened) or whether the final product can be classified as a spread. The cheese sample data yielded a number of specified whey cheese products (i.e. ricotta), allowing for categorization based on the specific cheese name identified in the FoodEx2´s extended terms. There were however, nine whey cheese samples that were unspecified, six from Norway, three from Sweden. Traditionally, whey cheese products in Norway and Sweden are produced through a process which does not include ripening. Also, when checking nutritional information, these unspecified whey cheese products contained a high amount of lactose, further confirming the likelihood of a non-ripening process. For these reasons, the unspecified whey cheese samples from Norway and Sweden were categorized as “*fresh uncured cheese*”.

**Processed cheese and spreads:**

“Process(ed) cheese and spreadable process(ed) cheese are made by grinding, mixing, melting and emulsifying with the aid of heat and emulsifying agents one or more varieties of cheese, with or without the addition of milk components and/or other foodstuffs.”(108, p36) Foodstuffs referenced refer to optional ingredients which may include cream, butter and butteroil; certain milk products, yielding a maximum of 5% lactose content in the final product; salt; vinegar; spices and other vegetable seasonings; other foods which purpose is to add seasoning to the product as long as it does not exceed one sixth of total solid weight of the final product; cultures of harmless bacteria and enzymes (108).

**Ripened cheese:**

Ripened cheese is defined as a “cheese which is not ready for consumption shortly after manufacture but which must be held for such time, at such temperature, and under such other conditions as will result in the necessary biochemical and physical changes characterizing the cheese in question." (107, p76) Due to their fermentation process, they are considered a cheese free of lactose (67). In cases where name was not enough to conclude cheese type, consideration was given to the amount of sugar in the cheese product. All ripened cheese categorized had 4 g or less sugar, a majority under one gram.

**Brined cheese:**

"[Brined cheeses] have no actual rind and have been ripened and preserved in brine until delivered to, or prepacked for, the consumer. Certain individual cheeses in brine contain specific herbs and spices as part of their identity." (107, p64)

### 5.4.2 Collection and categorization of bread data

**Collection of bread data**

Searches were completed in the databases using the following words: bread, baguette, chapatti, ciabatta, flatbread, matzo, pita, pumpernickel, pizza bases, roll(s), roti and tortilla. Filled breads, breadcrumbs or instances where bread appeared as a part of a number of ingredients were all not included in the final data. Also excluded were breads such as "ginger bread" which could be better classified as a sweet or dessert, and situations where the bread was altered after being baked, i.e. "poor knights" bread, which is dipped into egg batter and fried. Alternatives to bread such as crispbread, crackers, rusks and gluten-free alternatives were not included.

**Categorization of bread**

Using the FoodEx2 classification, bread was divided into two categories (leavened and unleavened) based on leavening agent presence.

Leavened bread is a bread which uses a leavening agent such as yeast, baking powder or baking soda to produce fermentation, providing an airy, lighter bread product.

Unleavened bread, also commonly referred to as flatbread as it does not use a leavening agent, included items identified as pizza bases, pita bread, matzo, tortilla, roti and chapatti. (See Appendix D for bread by FoodEx2 classification.)

### 5.4.3 Collection and categorization of ready-to-eat breakfast cereal

**Collection of ready-to-eat breakfast cereal data**

A general search was completed in each FCDB/FCT using keywords of cereal, corn, wheat, weet, rice, muesli, oat and flake, to capture all items meeting our defined criteria requirements for “ready-to-eat breakfast cereal”.

The goal was to capture breakfast cereal products used as a convenience food item and typically consumed with milk, without the need of cooking or heating. Those that are processed, popped or mixed with other products and sold in the breakfast cereal aisle at a supermarket. Values are presented in dry form, not mixed with milk or similar beverage.

**Categorization of ready-to-eat breakfast cereal**

Using the FoodEx2 system of categorization, the hierarchy term “cereal grains and similar and primary derivatives thereof” has several falling categories, many of which included single whole grains, not typically consumed as a breakfast cereal. Those that fit best with the defined area of focus included “cereal flakes and similar”, “popped cereals” (combined to one group “flakes, popped and similar”) and “Muesli and similar”. (See Appendix E for RTEBC by FoodEx2 classification.)

In addition to separating breakfast cereals by category of cereal, we also separated by whether or not the breakfast cereal item contained fruit, as fruit is a source of sugar. There was little description given on each breakfast cereal item, fruit´s presence was concluded by title only, sometimes, especially in Muesli mixes, there was doubt to whether the item contained fruit or not, hence an “unknown” column was included.

## 5.5 Instruments for healthier food classifications

To compare results with “healthy food standards”, a combination of the United Kingdom´s (UK) Food Standard Agency´s (FSA) salt target averages for specific foods, front of pack (FoP) color-coded labelling and the *Keyhole* (Appendix B) systems were referenced where applicable.

## Comparison with nutrition scoring: Instruments of classification

### Cheese: Target saturated fat levels

A tool to help access if a food product is high or low in sugar, saturated fat or sodium are the UK´s front-of-pack (FoP) voluntary nutrition label standards. These protocol standards were developed by the UK´s Department of Health, the Food Standards Agency, and devolved administrations in Scotland, Northern Ireland and Wales in collaboration with the British Retail Consortium. The purpose of this system is to help show at a glance if a food item is considered to be high, medium or low in the amounts of sodium, sugar, fat and saturated fat, with an overall objective to help in choosing healthier food items. This system does not replace the full mandatory nutrition labeling found at the back of the product package; it is a voluntary addition. The color red indicates a product that is considered high in the cautionary nutrient, its consumption is allowable, but thought should be given to moderation and portion size. Amber is significant of neither low nor high in the cautionary nutrient, green is significant of a healthier choice in respect to the nutrient amount (109). Table 4 provides a summary of requirements for each.

Table 4: The UK´s FoP color coding requirements per 100 g of a food item

| Nutrient | Red | Amber | Green |
|---|---|---|---|
| Sugar | > 22.5 g | ≥ 5 g ≤ 22.5 g | ≤ 5 g |
| Fat | > 17.5 g | ≥ 3 g ≤ 17.5 g | ≤ 3 g |
| Saturated fat | > 5 g | ≥ 1.5 g ≤ 5 g | ≤ 1.5 g |
| Salt | > 1.5 g | ≥ 0.3 g ≤ 1.5 g | ≤ 0.3 g |
| Sodium equivalent* | > 590 mg | ≥ 118 mg ≤ 590 mg | ≤ 118 mg |

Adapted from the UK´s *Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets*, 2016(109)
* based on equivalent equation of 1 g salt (NaCl) = 393.4 mg Na

### Cheese: Target sodium levels

A measurable example of target sodium levels for cheese is derived from the United Kingdom´s Food Standards Agency (FSA). Together with the UK Department of Health, population salt reduction measures in the UK were formulated. The FSA works with the food industry to reduce sodium content in processed foods on a voluntary basis. As a component to the UK´s national salt reduction strategy, specific salt reduction targets, average and maximum levels, were set for several processed foods (110). Cheese targets are divided by 7 different types. (Table 5) Small differences are set between five year increments, as population wide salt reduction is recommended to be introduced gradually.

Table 5: Target average and maximum salt/sodium in cheese products per 100 g, source FSA 2017(110,111).

| Cheese type | 2017 Target Average | 2017 Target Max. | 2012 Target Average | 2012 Target Max. |
| --- | --- | --- | --- | --- |
| Cheddar and similar “hard pressed” cheeses | 1.75 g salt or 700 mg sodium | 2 g salt or 800 mg sodium | 1.8 g salt or 720 mg sodium | 2 g salt or 800mg sodium |
| “Fresh cheese” except cottage | 0.5 g salt or 200 mg sodium | 0.68 g salt or 270 mg sodium | 0.55 g salt or 220 mg sodium | 0.75 g salt or 330 mg sodium |
| Cottage cheese | 0.5 g salt or 200 mg sodium | 0.53 g salt or 210 mg sodium | 0.55 g salt or 220 mg sodium | 0.63 g salt or 250 mg sodium |
| Mozzarella | 1.35 g salt or 540 mg sodium | - | 1.5 g salt or 600 mg sodium | - |
| Blue cheese | 2 g salt or 800 mg sodium | - | 2.1 g salt or 840 mg sodium | - |
| Processed spreads | 1.63 g salt or 650 mg sodium | 1.8 g salt or 720 mg sodium | 1.63 g salt or 650 mg sodium | 2.25 g salt or 900 mg sodium |
| Processed other | 1.7 g salt or 650 mg sodium | 2.0 g salt or 800 mg sodium | 2.0 g salt or 800 mg sodium | - |

**Bread: Target sodium levels**

Table 6 gives recommended target and maximum sodium bread levels from the UK´s Food Standard Agency´s (FSA) salt reduction measures.

Table 6: Target average and maximum salt/sodium in bread products per 100 g, source FSA 2017

| Bread type | 2017 Target Average | 2017 Target Max. | 2012 Target Average | 2012 Target Max. |
|---|---|---|---|---|
| Bread and rolls* | 0.9 g salt or 360 mg sodium | 1.13 g salt or 450 mg sodium | 1.0 g salt or 400 mg sodium | - |

* "Includes all bread and rolls: pre-packed, part-baked and freshly baked (including retailer in-store bakery) white, brown, malted grain, wholemeal and 50:50 bread or rolls including seeded products, French bread, ciabatta, focaccia, pitta, naan, chappattis, tortillas etc without "high salt" additions (e.g. cheese, olives, sundried tomatoes etc" (111)

**Ready-to-eat breakfast cereal: Target sugar levels**

The United Kingdom´s front-of-pack (FoP) voluntary nutrition label standards (Table 4) were also used an instrument of measure to assess target sugar levels in RTEBC.

## 5.6 Statistical analysis

### 5.6.1 Procedure

Descriptive statistics (means, median, standard deviations, maximums, minimums and percentages) were calculated for the dependent variables (saturated fat, sodium and sugar) on each of the selected food items (cheese, bread and RTEBC). The Kruskal-Wallis test was completed on each dependent variable to determine if there were similarities in their distribution across the six European countries in each of the selected food items. A pairwise comparison test with the Bonferroni correction for post-hoc test, was completed to determine between which countries statistical differences had occurred. These tests (along with the Man-Whitley U test for a comparison of 2 groups) were also completed on the dependent variable between the specific food categories within each food item grouping and among the specific food categories across countries. A statistical analysis was conducted using IBM SPSS Statistics 24. The significance level was set at a p-value less than 0.05 (112).

**Application of sample mean or median values per serving**

In each of the selected food items (cheese, bread, RTEBC), results were presented per 100 g. In order to measure the impact that an average serving of a selected food may have on total sodium, sugar or saturated fat intake, results were calculated to a standard serving size. Recommended serving sizes for cheese, bread and RTEBC vary by country, therefore a standard serving size was chosen for each item, based on common standards viewed in literature. For cheese and bread, a 50-g standard serving size was used; for RTEBC items, 35 g.

Depending on the form of application, either the median or mean results from our study were used. In instances where several outliers were observed, more accuracy was given to the median. When comparing our results to other population results in which average values were referenced, the mean values of our results were used.

**Application of sample means with average intakes of food items**

Results were compared to the recommended or maximum level intakes of sodium, sugar and saturated fat as defined in the literature review section. For saturated fat, the WHO and the FAO both support lowering the risk of NCDs in recommending the reduction of saturated fats to contributing less than 10% of total daily calories (5,6). For sodium, the WHO recommends that intake be reduced to less than 2 g per day, or 5 g of salt per day for persons 16 years of age or older (17). For sugar, the general guidelines (in accordance with the EFSA) were used and sugar was given an upper limit value of 90 g per day based on a 2000 level calorie diet (45). Applying this recommendation to an average 2000 level calorie diet yields a general recommended maximum intake of 22 g saturated fat per day. Application of results is meant to reflect nutritional recommendations for average, healthy persons 16 years of age or older.

# 6. RESULTS

**Results cheese data**

In total, there were 336 samples of cheese used in the comparison for both their sodium and saturated fat nutrient values. Some nutrient values were missing from samples, resulting in 326 (97%) total samples from saturated fat and 329 (98%) total samples for sodium.

## 6.1 Saturated fat in cheese

Table 7 presents a summary of the cheese data´s characteristics for saturated fat. The majority of the samples came from Belgium (125, 38.3%) and the least came from Portugal (22, 6.7%). From the entire sample, a majority of the cheeses were categorized as *ripened cheeses (RC)* (197, 60%), followed by *fresh uncured cheese (FUC)* (81, 25%), then *processed cheese and spreads (PCS)* (39, 12%) and lastly *brined cheese (BC)* (9, 3%).

Table 7: Count of cheese items in sample (with saturated fat data available)

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | TOTAL |
|---|---|---|---|---|---|---|---|
| Total (n) number of cheeses | 125 | 76 | 27 | 22 | 27 | 49 | 326 |
| Percent of total cheese | 38.3% | 23.3% | 8.3% | 6.7% | 8.3% | 15.0% | 100% |
| Number (n) of *Fresh uncured cheese* (*) | 16 (13%) | 25 (33%) | 10 (37%) | 8 (36%) | 6 (22%) | 16 (33%) | 81 (25%**) |
| Number (n) of *Processed cheese and spreads* (*) | 10 (8%) | 10 (13%) | 1 (4%) | 2 (9%) | 5 (19%) | 11 (22%) | 39 (12%**) |
| Number (n) of *Ripened cheese* (*) | 97 (77%) | 39 (51%) | 15 (55%) | 12 (55%) | 15 56%) | 19 (39%) | 197 (60%**) |
| Number (n) of *Brined cheese* (*) | 2 (2%) | 2 (3%) | 1 (4%) | 0 (0%) | 1 (4%) | 3 (6%) | 9 (3%**) |

*Percent of cheese type within country´s cheese sample
**Percent of cheese type within total cheese samples

A view of descriptive statistics for saturated fat amounts in the cheese sample is provided in Table 8.

Table 8: Descriptive statistics of saturated fat (g) per 100 g of cheese

| | Min | Max | Mean | Median | sd |
|---|---|---|---|---|---|
| **All cheeses, n=326** | **0.05** | **29.50** | **14.50** | **16.60** | **6.79** |
| **Per country** | | | | | |
| Belgium, n=125 | 0.10 | 29.50 | 16.33 | 17.90 | 6.38 |
| Norway, n=76 | 0.40 | 29.50 | 15.26 | 17.00 | 6.41 |
| Poland, n=27 | 0.28 | 25.04 | 12.96 | 15.51 | 7.18 |
| Portugal, n=22 | 0.10 | 19.30 | 10.55 | 12.10 | 5.73 |
| Serbia, n=27 | 0.05 | 26.00 | 13.11 | 15.90 | 7.33 |
| Sweden, n=49 | 0.66 | 27.87 | 12.06 | 11.15 | 6.79 |
| **Cheese categories** | | | | | |
| *FUC*, n=77 | 0.45 | 29.50 | 10.08 | 8.00 | 8.07 |
| *PCS*, n=38 | 1.90 | 22.40 | 10.45 | 9.50 | 5.29 |
| *RC*, n=187 | 0.30 | 29.30 | 17.13 | 18.00 | 5.08 |
| *BC*, n=9 | 10.33 | 17.53 | 14.30 | 14.70 | 2.65 |

sd=standard deviation, FUC= *fresh uncured cheese*, PCS= *processed cheese and spreads*, RC= *ripened cheese*, BC= *brined cheese*

### 6.1.1 Comparison of saturated fat in all cheese samples across countries

In the sample of cheeses from the six countries, there was a statistically significant difference in grams of saturated fat between countries. ($\chi^2(5)=30.605$, $p<0.01$, $n=326$). According to the multiple comparison, Belgium presents a distribution of saturated fat statistically significant from Portugal ($p<0.01$) and Sweden ($p<0.01$). In Belgium, the highest levels of saturated fat are observed. Also according to the multiple comparison, Norway presents a distribution of saturated fat statistically significant from Portugal ($p=0.022$). The inter-quartile range with the lowest levels of saturated fat are observed in Portugal. (Figure 1)

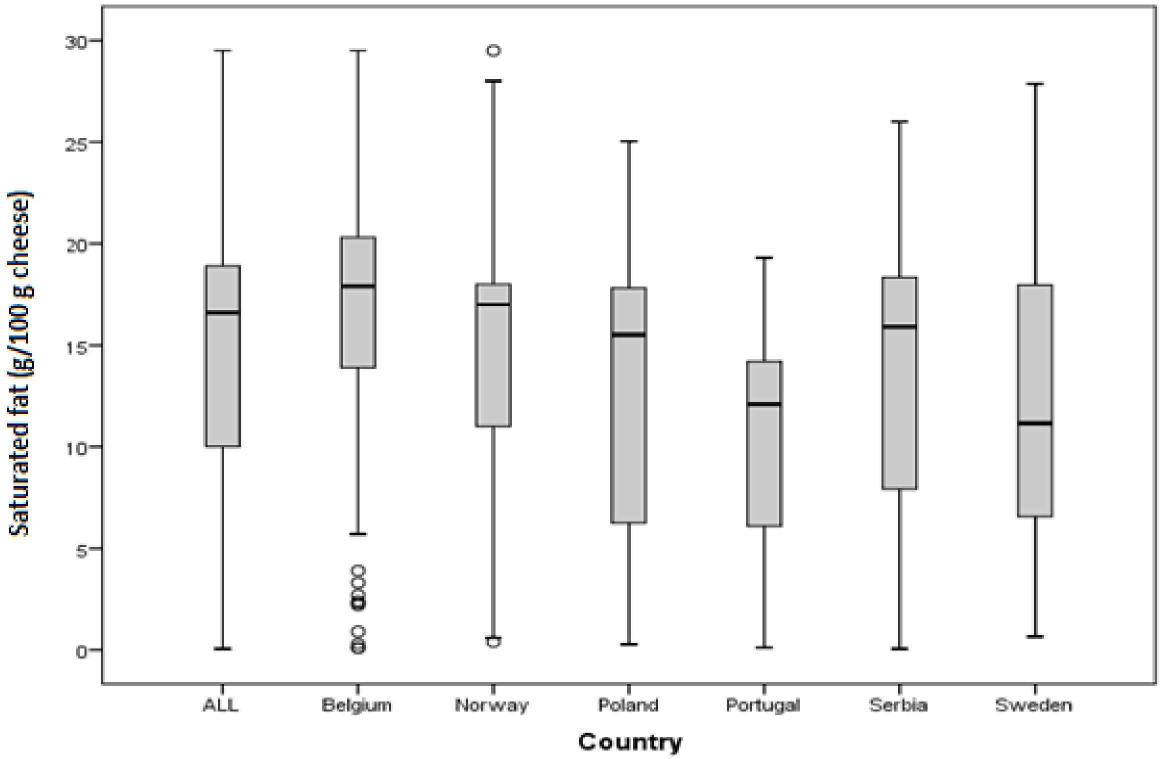


Figure 1: SFA content of cheese by country (p<0.001)

### 6.1.2 Comparison of saturated fat among cheese categories

A lot of variation was found among each country´s samples (standard deviation range of 5.726 - 7.331) and within each cheese category, especially *fresh uncured cheese* (sd=8.070), indicating that grouping of cheese categories may not always yield nutritional expectation of a saturated fat value. The Kruskal-Wallis test was applied to saturated fat values separated by cheese category, and statistical difference was found ($\chi^2(3)=78.736$, $p<0.01$, n= 326). Pairwise comparison showed statistical difference between f*resh, uncured cheese* category and *ripened cheese* ($p<0.01$). There was also statistical difference between *ripened cheese* and *processed cheese and spreads* ($p<0.01$). *Ripened cheese* has an inter-quartile range with the highest values of saturated fat. (Figure 2)

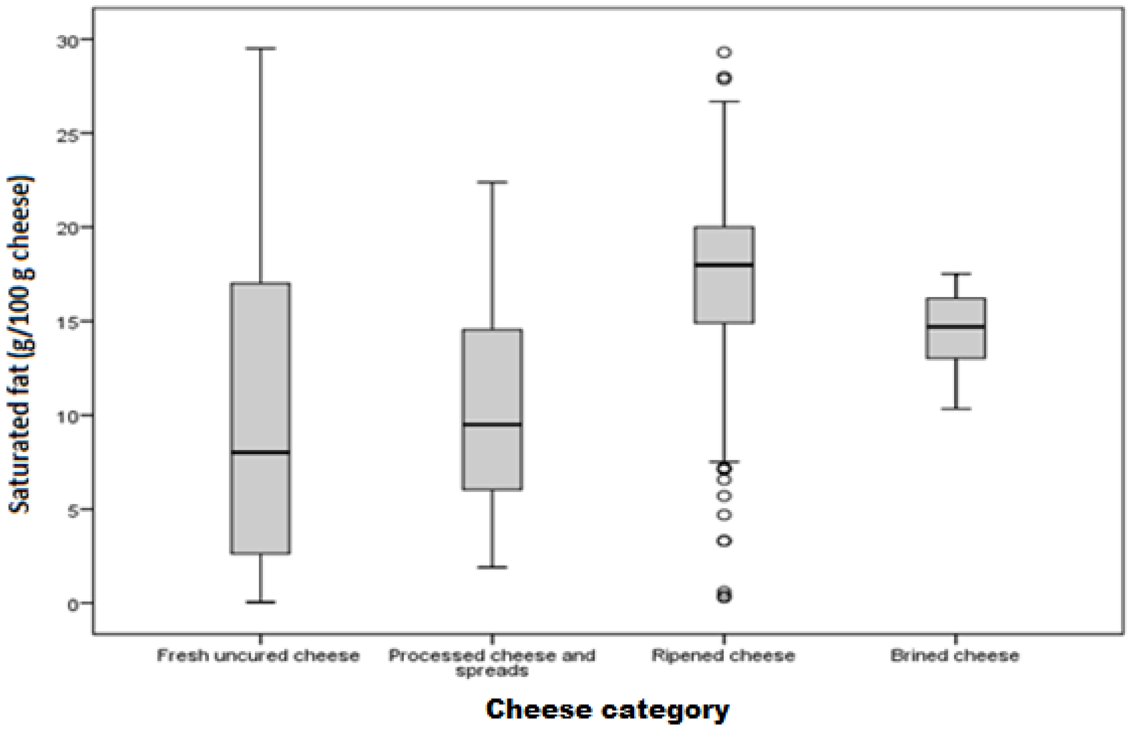


Figure 2: Variation of SFA by cheese category, samples from all countries (p<0.001)

### 6.1.3 Comparison of saturated fat in cheese categories across countries

In Belgium, 77% of cheeses from its sample fall into the *ripened cheese* category compared to the other countries whose percentages range from 39-60%. (Table 7). When strictly comparing *ripened cheese* among countries, there remained a statistical difference in grams of saturated fat ($\chi^2(5)=13.932$, $p=0.016$, $n=197$). According to the multiple comparison, Belgium´s *ripened cheese* sample presents a distribution of saturated fat statistically significant from Portugal ($p=0.020$).

No difference was found in distribution by country of saturated fat in the *processed cheese and spreads* category ($\chi^2(5)=5.551$, $p=0.352$, $n=39$).

There was statistical significance of saturated fat found in the *fresh uncured cheese category* when separated by country ($\chi^2(5)=17.131$, $p=0.004$, $n=81$). The multiple comparison yielded no significant differences between countries by our set standards; however, differences between Portugal and Norway were near significant ($p=0.05$). By visual inspection of boxplot interquartile ranges, (figure 3) Norway has an interquartile range of saturated fat in *fresh uncured cheese* higher than the IQR´s of all other countries.

Comparison by country of saturated fat distributions for each of these cheese categories are represented in Figure 3.

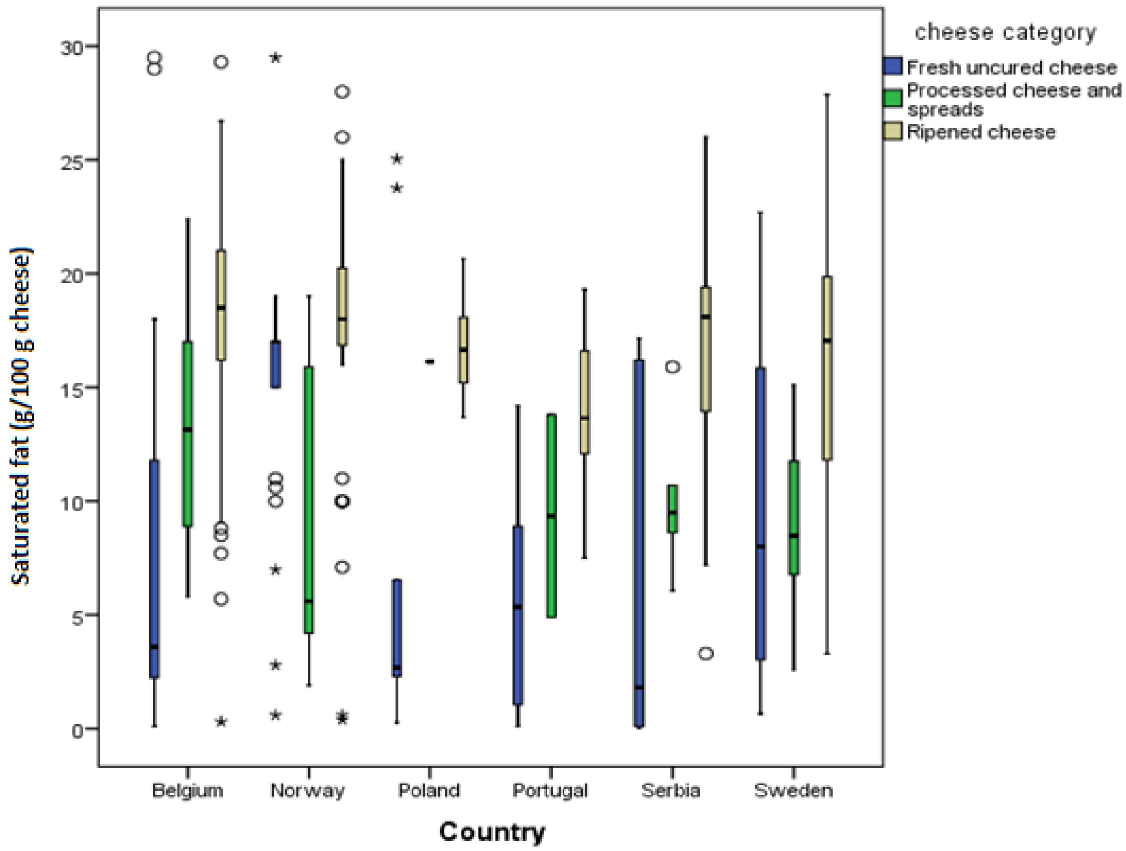


Figure 3: SFA content, cheese categories by country (*fresh uncured* p=0.004, *processed* p=0.352, *ripened* p=0.016)

### 6.1.4 Comparison with recommendations

**Comparison to the UK´s FoP nutrition label requirements**

Using the FoP label classification for saturated fat per 100 g, greater than 5 g of saturated fat is considered a red, cautionary food item. Belgium, Poland and Serbia have 50% or more of their *fresh uncured cheeses* under 5 g saturated fat. (Table 9). Brined cheeses were not included due to low count, n=9.

**Application of sample median saturated fat values per serving of cheese**

Several outliers were observed in the data results (Figures 1&3), therefore when applying an estimation of the food product´s overall potential effect on population, median values were used. A global and individual country view of the saturated fat medians of the cheese samples from the six countries is presented in Table 9. With the findings from our convenience sample, the potential impact that one 50-g serving of cheese from each country may have on total saturated fat allowance per day was estimated. As referenced in the methods section, total daily saturated fat limit was calculated based on the WHO´s 2015-2020 Dietary Guidelines recommendation of keeping saturated fat consumption less than 10% of total caloric intake per day. This recommendation was applied to an average 2000 level calorie diet, yielding approximately 22 g of saturated fat per day. Based on the median from the entire sample, a single 50-g serving of cheese from the studied countries consumes approximately 38% of the average person´s daily saturated fat allowance.

Table 9: Saturated fat median of all cheese categories, by country

| | Median SFA per 100 g cheese | SFA per 50-g cheese serving | % of daily SFA per 50-g serving* |
|---|---|---|---|
| **All cheese categories** | **16.6** | **8.3** | **38%** |
| Belgium | 17.9 | 9.0 | 41% |
| Norway | 17.0 | 8.5 | 39% |
| Poland | 15.5 | 7.8 | 35% |
| Portugal | 12.1 | 6.1 | 28% |
| Serbia | 15.9 | 8.0 | 36% |
| Sweden | 11.2 | 5.6 | 26% |
| **All FUC, n=77** | 8.0 | 4.0 | 18% |
| Belgium, n= 16 | 3.6 | 1.8 | 8% |
| Norway, n=25 | 17 | 8.5 | 38% |
| Poland, n=10 | 2.7 | 1.3 | 6% |
| Portugal, n=8 | 5.4 | 2.7 | 12% |
| Serbia, n=6 | 1.8 | 0.9 | 4% |
| Sweden, n=16 | 8.0 | 4.0 | 18% |
| **All PCS, n=38** | 9.5 | 4.8 | 22% |
| Belgium, n=10 | 13.1 | 6.6 | 30% |
| Norway, n=10 | 5.6 | 2.8 | 13% |
| Poland, n=1 | - | - | - |
| Portugal, n=2 | 9.4 | 4.7 | 21% |
| Serbia, n=5 | 9.5 | 4.8 | 22% |
| Sweden, n=11 | 8.5 | 4.2 | 19% |
| **All RC, n=187** | 18 | 9 | 41% |
| Belgium | 18.5 | 9.3 | 42% |
| Norway | 18 | 9.0 | 41% |
| Poland | 16.7 | 8.3 | 38% |
| Portugal | 13.7 | 6.8 | 31% |
| Serbia | 18.1 | 9.0 | 41% |
| Sweden | 17.1 | 8.5 | 39% |

FUC= *fresh uncured cheese*, PCS= *processed cheese and spreads*, RC= *ripened cheese*
*Percent of daily allotment, WHO recommendations to limit to 10% of calories, applied to average 2000 level calorie diet

### Estimation of saturated fat intake from cheese by country

In Table 10, average consumption of cheese per day is used along with mean values of saturated fat per country to estimate possible daily contribution of cheese on saturated fat totals.

Table 10: Estimates of potential SFA contribution from cheese

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | All |
|---|---|---|---|---|---|---|---|
| Mean SFA g/100 g cheese, all samples | 16.3 | 15.3 | 13.0 | 10.5 | 13.1 | 12.1 | 14.5 |
| Average cheese intake g/day[a] | 32.5 | 41.0 | 27.6 | 21.3 | ~ | 25.0 | 29.5[b] |
| Potential SFA (g/day) intake from cheese[c] | 5.3 | 6.3 | 3.6 | 2.3 | ~ | 3.0 | 4.3 |
| Potential % of daily SFA allotment[d] | 24.1% | 28.4% | 16.3% | 10.2% | ~ | 13.7% | 19.5% |

a) From most recent NFCS and HBS survey data (Appendix A). Not all average cheese intakes come from same age groupings. Age brackets are as follows: Belgium: 18-64 year-olds; Norway:18-70 year-olds; Poland: all ages; Portugal: 18-64 year-olds; Sweden: 18-80 year-olds. Estimates are not meant for direct comparison across countries, as estimated averages came from different surveys each using different years, methodologies and standards of reporting.
b) Average from five countries providing data
c) Utilizing information from NFCSs and HBS on average cheese intake per day per country and applied to the mean value of the samples studied from each country
d) Percent of SFA allotment occupied by the average cheese intake (per country), when applying mean SFA values from cheese samples available per country

## 6.2 Sodium in cheese

Table 11 presents the count of cheese data for sodium. The same sample was used for both sodium and saturated fat data, making this table very similar to Table 7. Differences in count are due to missing values (of either saturated fat or sodium) in the cheese products analyzed.

Table 11: Count of cheese items in sample (with sodium data available)

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | TOTAL |
|---|---|---|---|---|---|---|---|
| Total (n) number of cheeses | 125 | 76 | 27 | 22 | 30 | 49 | 329 |
| Percent of total cheese | 38.0% | 23.1% | 8.2% | 6.7% | 9.1% | 14.9% | 100% |
| Number (n) of *Fresh uncured cheese* (*) | 16 (13%) | 25 (33%) | 10 (37%) | 8 (36%) | 6 (20%) | 16 (33%) | 81 (25%**) |
| Number (n) of *Processed cheese and spreads* (*) | 10 (8%) | 10 (13%) | 1 (4%) | 2 (9%) | 6 20%) | 11 (22%) | 40 (12%**) |
| Number (n) of *Ripened cheese* (*) | 97 (77%) | 39 (51%) | 15 (55%) | 12 (55%) | 17 56%) | 19 (39%) | 199 (60%**) |
| Number (n) of *Brined cheese* (*) | 2 (2%) | 2 (3%) | 1 (4%) | 0 (0%) | 1 (4%) | 3 (6%) | 9 (3%**) |

*Percent of cheese type within country´s cheese sample
**Percent of cheese type within total cheese samples

### 6.2.1 Comparison of sodium in all cheese samples across countries

Distribution of sodium values separated by country was not statistically significant ($\chi^2(5)=5.526$, p=0.329, n=329). (Figure 4). Table 12 provides a summary of descriptive data. Overall, the sample was widely spread with standard deviations of sodium within countries ranging from 313–442 mg.

Table 12: Descriptive statistics of sodium (mg) per 100 g of cheese

| | Min | Max | Mean | Median | sd* |
|---|---|---|---|---|---|
| **All cheeses, n=329** | **16** | **2924** | **614** | **590** | **354** |
| **Per Country** | | | | | |
| Belgium, n=125 | 16 | 2924 | 623 | 620 | 343 |
| Norway, n=76 | 24 | 1600 | 593 | 520 | 330 |
| Poland, n=27 | 36 | 1860 | 628 | 674 | 442 |
| Portugal, n=22 | 37 | 1560 | 694 | 780 | 430 |
| Serbia, n=30 | 39 | 1430 | 642 | 535 | 389 |
| Sweden, n=49 | 28 | 1287 | 568 | 491 | 314 |
| ***Cheese category*** | | | | | |
| *FUC*, n=81 | 16 | 920 | 278 | 300 | 218 |
| *PCS*, n=40 | 300 | 1390 | 852 | 915 | 290 |
| *RC*, n=190 | 24 | 2924 | 688 | 615 | 319 |
| *BC*, n=9 | 576 | 1200 | 966 | 1000 | 216 |

*sd=standard deviation

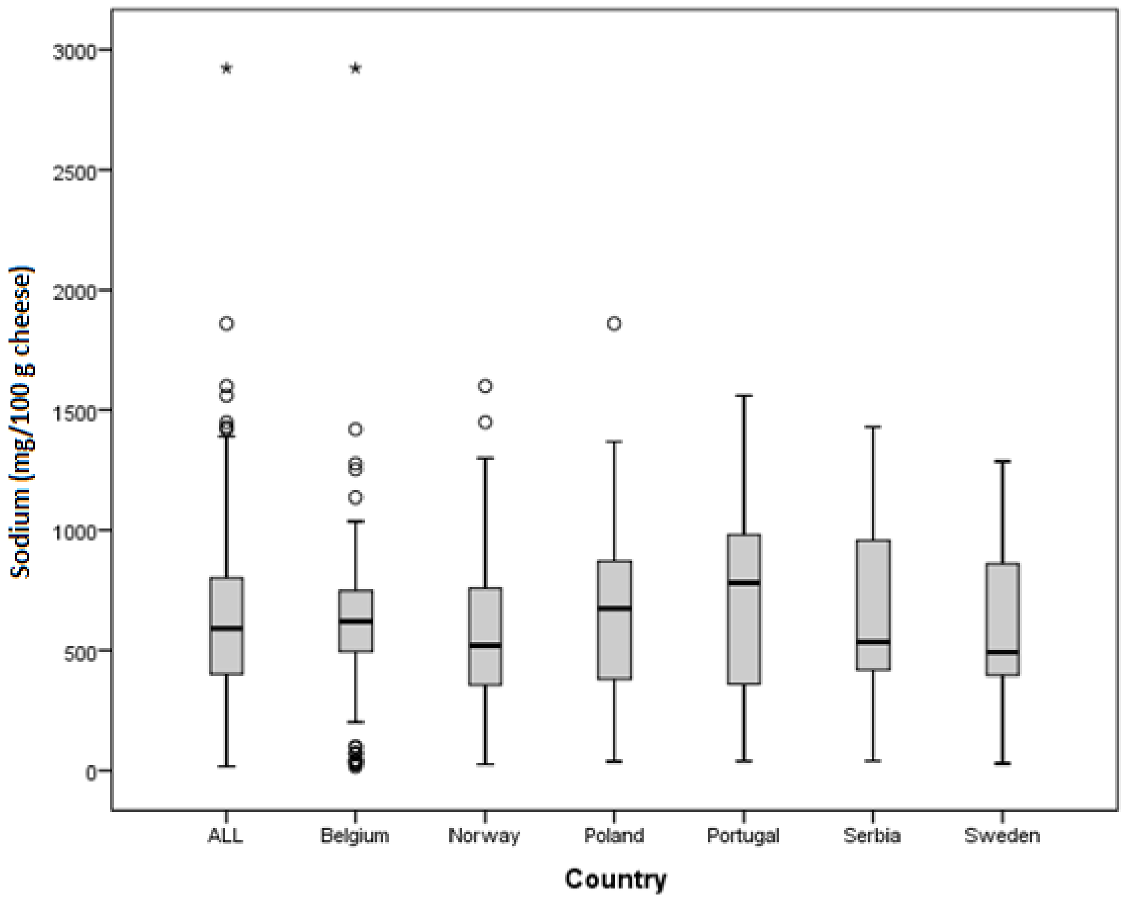


Figure 4: Sodium content of cheese by country (p=0.355)

### 6.2.2 Comparison of sodium among cheese categories

Standard deviation range is less when grouping by cheese categories (sd=218-319). The *ripened cheese* category presents the most deviation (sd=319), it also contains the most outliers within the sample. Across cheese categories, the distribution of sodium is statistically different ($\chi^2(3)=131.776$, $p<0.001$, n=329). The *fresh uncured cheese* category is statistically different in its distribution of sodium when compared individually to all other cheese categories ($p<0.001$). *Fresh uncured cheese* also presents the lowest median (3300 mg). Processed cheeses and spreads also have a higher distribution of sodium than do ripened cheeses. ($p=0.01$) (Figure 5)

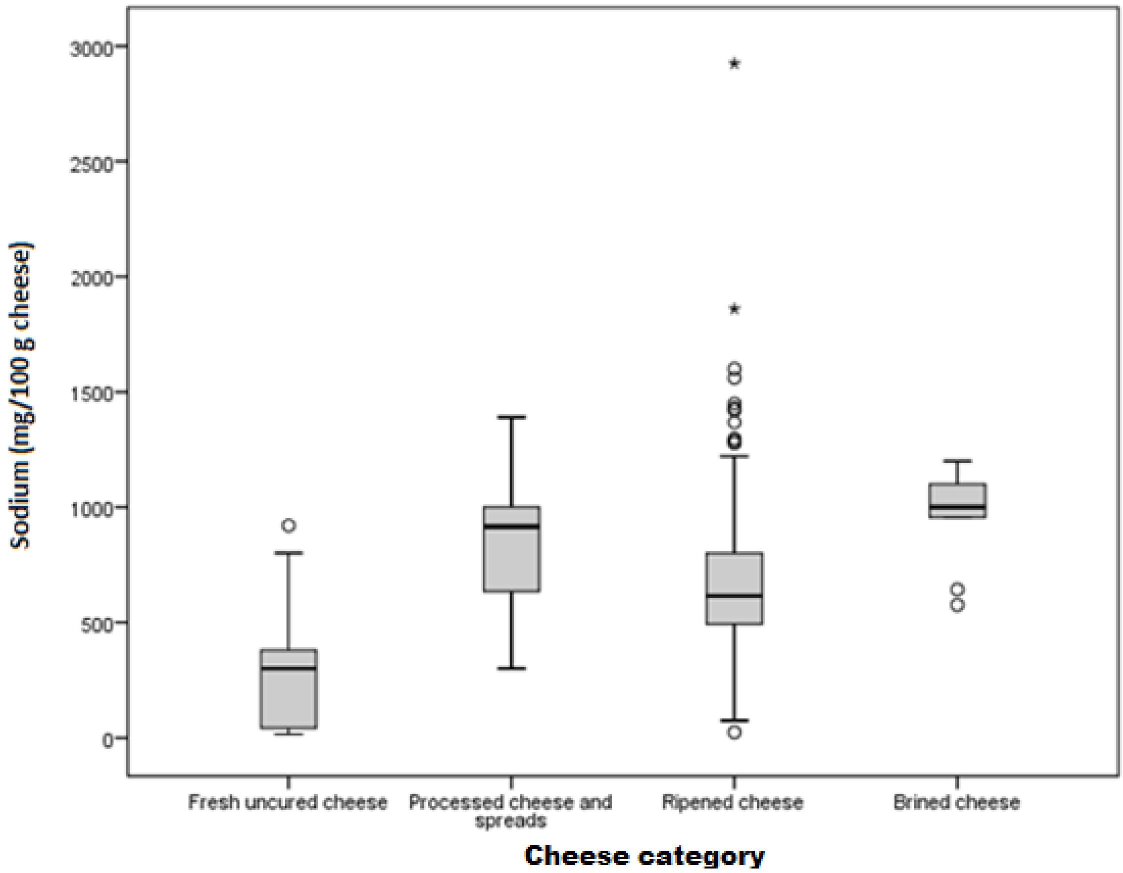


Figure 5: Variation of sodium by cheese category, samples from all countries (p<0.001)

### 6.2.3 Comparison of sodium in cheese categories across countries

No statistical differences in sodium distributions were observed across countries under the categories of *fresh uncured cheese* ($\chi^2(5)=10.225$, p=0.069, n=81), *processed cheese and spreads* ($\chi^2(5)=5.238$, p=0.388, n=40), nor *brined cheese* ($\chi^2(4)=5.723$, p=0.221, n=9). Statistical differences were observed in the *ripened cheese* category ($\chi^2(5)=26.177$, p<0.001, n=190). Table 13 shows the descriptive statistics. Pairwise comparison tests between countries showed statistical differences between Sweden´s distribution of *ripened cheese* compared with that of Poland´s (p=0.002) and Portugal´s (p=0.003). Norway´s distribution of *ripened cheese* was also statistically significant to that of Poland´s (p=0.017) and Portugal´s (p=0.020). Poland and Portugal have IQRs containing the highest values of sodium; Norway and Sweden contain the lowest. (Figure 6)

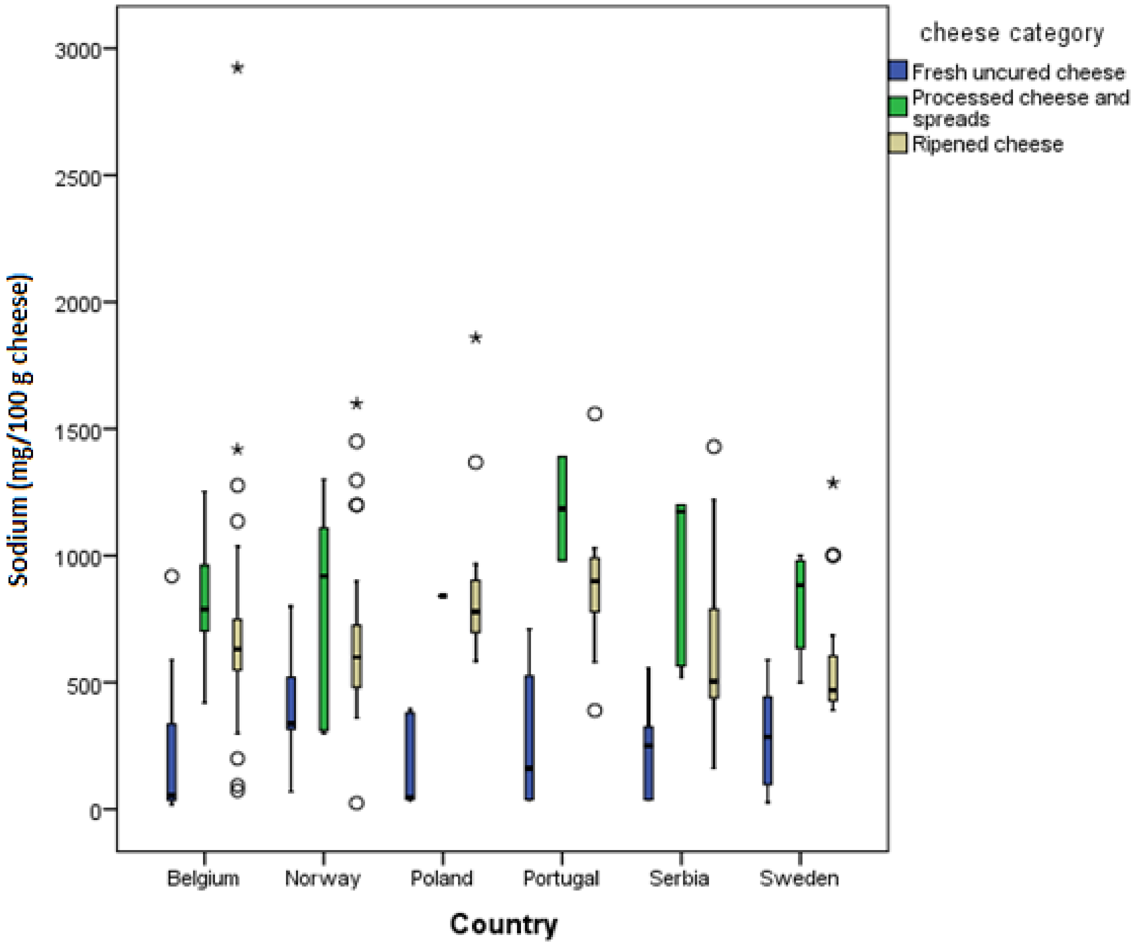


Figure 6: Sodium content, cheese category by country (*fresh uncured* p=0.069; *processed* p=0.338; *ripened* p<0.001)

Table 13: Descriptive statistics of sodium (mg) per 100 g of *ripened cheese* only

| | Min | Max | Mean | Median | Sd |
|---|---|---|---|---|---|
| All Countries, n=199 | 24 | 2924 | 688 | 615 | 319 |
| Belgium, n=97 | 74 | 2924 | 676** | 632 | 313 |
| Norway, n=39 | 24 | 1600 | 650** | 600 | 319 |
| Poland, n=15 | 585 | 1860 | 882 | 780 | 333 |
| Portugal, n=12 | 390 | 1560 | 890 | 900† | 280 |
| Serbia, n=17 | 161 | 1430 | 648** | 504 | 347 |
| Sweden, n=19 | 390 | 1287 | 580** | 470 | 248 |

** denotes that mean is in compliance to FSA target average for sodium in “hard pressed” cheese products. In 2012 this target was 720mg/100g in 2017 700mg /100g.

†denotes that 50% or more of products are above FSA´s target maximum level of 800mg/100g.

Although no statistical differences were found between distributions of cheese samples´ sodium values in the *fresh uncured* and *processed cheese and spreads* categories across countries, a summary of their descriptive statistics is provided in Tables 14 and 15 respectively.

Table 14: Descriptive statistics of sodium (mg) per 100 g of *fresh uncured cheese* only

| | Min | Max | Mean | Median | Sd |
|---|---|---|---|---|---|
| All Countries, n=81 | 16 | 920 | 278 | 300 | 218 |
| Belgium, n=16 | 16 | 920 | 193** | 55.5 | 260 |
| Norway, n=25 | 70 | 800 | 374 | 338† | 168 |
| Poland, n=10 | 36 | 396 | 179** | 46 | 178 |
| Portugal, n=8 | 37 | 710 | 275 | 161 | 290 |
| Serbia, n=6 | 39 | 558 | 244 | 251 | 198 |
| Sweden, n=16 | 28 | 590 | 292 | 286 | 194 |

** denotes that mean is in compliance to FSA target average for sodium in “fresh cheese” products. In 2012 this target was 220mg/100g in 2017 200mg /100g.

†denotes 50% or more of products are above FSA´s maximum sodium targets for fresh cheese for both 2012 and 2017 targets. (Targets: 330mg/100g in 2012; 270 mg/100g in 2017)

Table 15: Descriptive statistics of sodium (mg) per 100 g of *processed cheese and spreads* only

| | Min | Max | Mean | Median | Sd |
|---|---|---|---|---|---|
| All Countries, n=40 | 300 | 1390 | 852 | 915 | 289 |
| Belgium, n=10 | 420 | 1253 | 798 | 789 | 253 |
| Norway, n=10 | 300 | 1300 | 815 | 920† | 375 |
| Poland, n=1 | - | - | 841 | - | - |
| Portugal, n=2 | 980 | 1390 | 1185 | 1185† | 290 |
| Serbia, n=6 | 519 | 1200 | 972 | 1174† | 334 |
| Sweden, n=11 | 500 | 1000 | 809 | 884 | 203 |

The mean values for the samples of all countries were not in compliance to FSA´s target average of sodium in “processed spreads” products nor in “processed other”. In 2012 and 2017 target average for “processed spreads” remains 650mg/100g. For “processed other”, targets were at 800mg/100g in 2012 and 650mg/100g.

† denotes that 50% or more of products are above all FSA´s maximum sodium targets for processed spreads and processed other (processed spreads: 900mg/100g in 2012 and 720mg/100g in 2017; processed other: no target in 2012, 800mg/100g in 2017)

### 6.2.4 Comparison with recommendations

**Comparison to the UK´s FSA target average and maximum sodium values**

Noted in Tables 13, 14 and 15 are mean and median values in compliance with the FSA target averages and maximums for sodium by each cheese type.

**Application of sample median sodium values per serving of cheese**

Total mean of all countries (614 mg) was similar to total median (590 mg). Due to several outliers, more reliability was given to median values. Table 16 gives representation of the estimated sodium amounts one serving (50 g) of cheese yields per median cheese value in each country. This number is then presented in percent of total sodium allotment per day. One 50-g serving of cheese consumes approximately 12-20% of total daily sodium recommended allotment.

Table 16: Sodium median of cheese globally and from individual countries

| | Median sodium mg/100 g cheese | Sodium mg per 50g cheese serving | Percent of sodium allotment (2g) |
|---|---|---|---|
| **All 6 countries** | **590** | **295** | **15%** |
| Belgium | 620 | 310 | 15.5% |
| Norway | 520 | 260 | 13% |
| Poland | 674 | 337 | 16.9% |
| Portugal | 780 | 390 | 19.5% |
| Serbia | 535 | 268 | 13.4% |
| Sweden | 491 | 246 | 12.3% |

**Estimation of sodium intake from cheese by country**

Table 17 applies average intake of cheese from each country to the mean sodium values from the cheeses in each country´s sample. An estimate of total potential contribution that cheese may have on daily sodium allotments is represented in percentage value to comply with WHO recommendations of 2g daily sodium intake.

Table 17: Estimates of potential sodium contribution from cheese

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | All |
|---|---|---|---|---|---|---|---|
| Mean sodium mg/100 g cheese, all samples | 623 | 593 | 628 | 694 | 642 | 568 | 614 |
| Average cheese intake g/day[a] | 32.5 | 41.0 | 27.6 | 21.3 | ~ | 25.0 | 29.5[b] |
| Potential sodium (mg/day) intake from cheese[c] | 202 | 243 | 192 | 148 | ~ | 142 | 181 |
| Potential % of daily sodium allotment[d] | 10.1% | 12.0% | 9.6% | 7.4% | ~ | 7.1% | 9.0% |

a) From most recent NFCS and HBS survey data (Appendix A). Not all average cheese intakes come from the same age groups. Age brackets are as follows: Belgium: 18-64 year-olds; Norway: 18-70 year-olds; Poland: all ages; Portugal: 18-64 year-olds; Sweden: 18-80 year-olds. Estimates are not meant for direct comparison across countries, as estimated averages came from different surveys each using different years, methodologies and standards of reporting.

b) Average from five countries providing data

c) Utilizing information from NFCSs and HBS on average cheese intake per day per country and applied to the mean value of the samples studied from each country

d) Percent of sodium allotment occupied by the average cheese intake (per country), when applying mean sodium values from cheese samples available per country

## 6.3 Sodium in bread

Table 18 presents a summary of the bread data´s characteristics. In total, there were 229 samples of bread compared for their amounts of sodium. The most samples were presented by Norway (n=67, 29%) and the least by Portugal (n=13, 6%). The samples were categorized mostly as *leavened bread* (n=216, 95%); there were very few samples of *unleavened or flat bread* (n=15, 5%).

Table 18: Count of bread items in sample

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | TOTAL |
|---|---|---|---|---|---|---|---|
| Total (n) number of bread items | 33 | 67 | 53 | 13 | 15 | 48 | 229 |
| Percent of total bread items | 14% | 29% | 23% | 6% | 7% | 21% | 100% |
| Number (n) of Leavened Bread (*) | 32 (97%) | 58 (87%) | 53 (100%) | 13 (100%) | 14 (93%) | 44 (92%) | 216 (95%**) |
| Number (n) of Unleavened or Flat Bread (*) | 1 (3%) | 9 (13%) | 0 (0%) | 0 (0%) | 1 (7%) | 4 (8%) | 15 (5%**) |

*Percent of bread type within country´s bread sample
**Percent of bread type within total bread samples

### 6.3.1 Comparison of sodium in all bread samples across countries

Table 19 lists several descriptive statistics of sodium from the bread sample. Countries holding the lowest bread medians were Portugal (290 mg), Norway (316 mg) and Sweden (362 mg). Belgium´s median (498 mg) and Serbia´s median (510 mg) were the highest.

In all bread samples, *leavened* and *unleavened and flat bread*, country of bread sample origin had a statistically significant effect on the amount of sodium ($\chi^2(5)= 56.049$, $p<0.001$, n=229). Referencing the multiple comparisons test by country, Norway presents a distribution of sodium significantly different from Poland ($p<0.001$), Belgium ($p<0.001$) and Serbia ($p<0.001$). Portugal´s distribution of sodium was significantly different from Belgium ($p=0.014$) and Serbia ($p=0.006$). Sweden´s distribution was also significantly different from Belgium ($p<0.001$) and Serbia ($p<0.001$). (Figure 7)

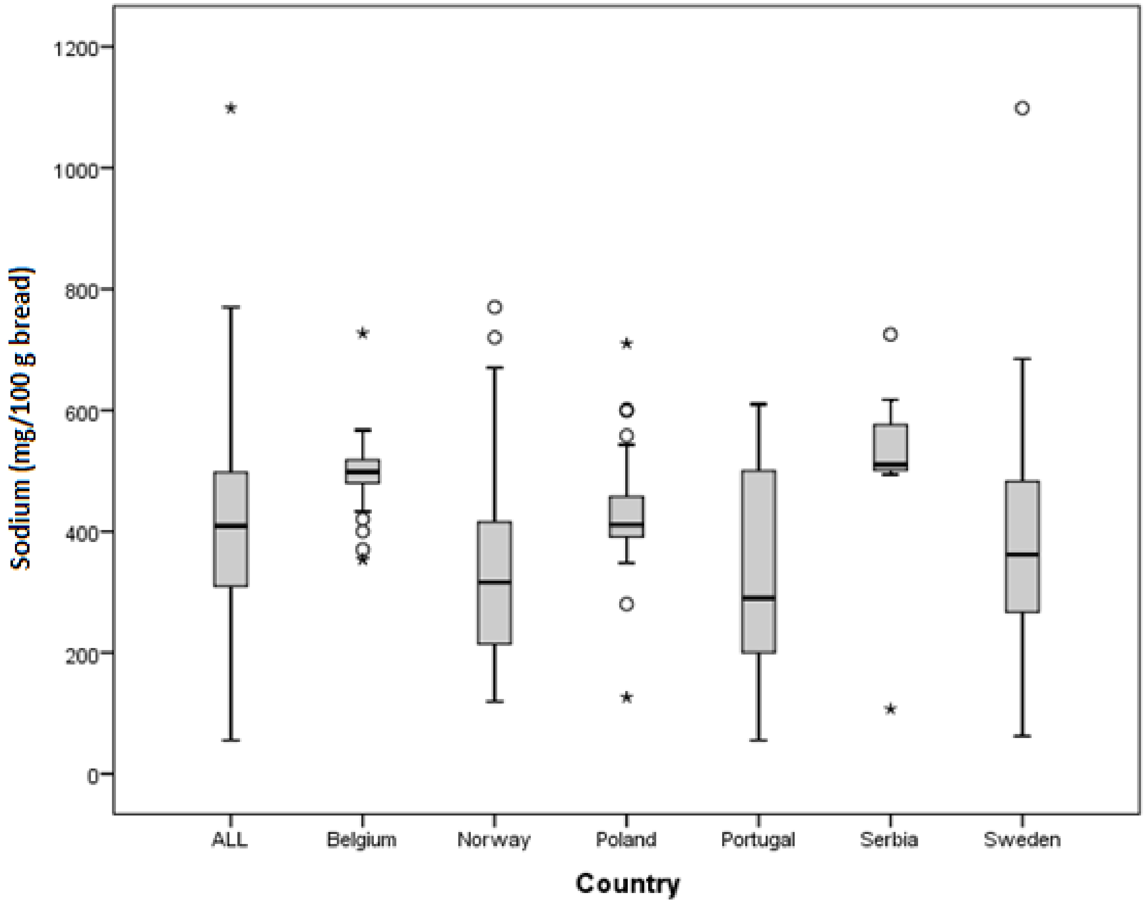


Figure 7: Sodium content of bread (both *leavened* and *unleavened or flat bread*) by country ($p<0.001$)

Table 19: Descriptive statistics of sodium (mg) per 100 g of bread, leavened and unleavened and flat bread together

| | Min | Max | Mean | Median | Sd |
|---|---|---|---|---|---|
| **All Countries, n=229** | **55** | **1099** | **400** | **409** | **149** |
| Belgium, n=33 | 354 | 727 | 489 | 498 | 67 |
| Norway, n=67 | 119 | 770 | 331 | 316 | 148 |
| Poland, n=53 | 126 | 710 | 429 | 411 | 83 |
| Portugal, n=13 | 55 | 610 | 329 | 290 | 194 |
| Serbia, n=15 | 107 | 725 | 519 | 510 | 131 |
| Sweden, n=48 | 62 | 1099 | 387 | 362 | 180 |
| *Leavened bread*, all countries, n=216 | 55 | 1099 | 394 | 406 | 143 |
| *Unleavened and flat bread*, all countries, n=15 | 156 | 770 | 495 | 508 | 197 |

sd=standard deviation

### 6.3.2 Comparison of sodium among bread categories

Overall, unleavened or flat bread had a higher median (508 mg) than did leavened bread (406 mg). (Table 19) As referenced in the methods section, due to comparison of only two groups, the Mann-Whitley U test was used. Distribution of sodium amounts are not statistically different across bread categories ($U$=2,118, $z$=2.068, $p$=0.039, n=229), see figure 8.

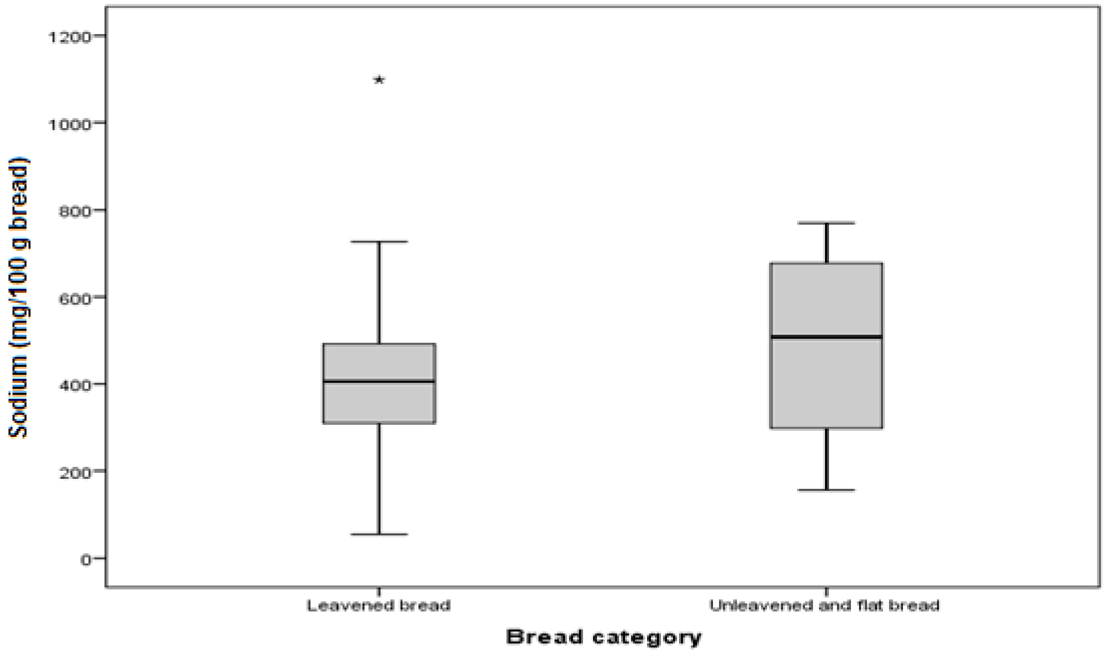


Figure 8: Variation of sodium by bread category, samples from all countries

### 6.3.3 Comparison of sodium in each category of bread across countries

No statistical differences in distribution were observed in the unleavened and flat bread samples ($\chi^2$(3)=0.263, p=0.967, n=15).

Table 20 presents the descriptive statistics for *leavened bread*. When comparing the *leavened bread* category only across countries, distribution of sodium was statistically different ($\chi^2$(5)=63.021, p<0.001, n=214). (Figure 10) Multiple comparisons between countries remained significant between Norway and the countries of Poland (p<0.001), Belgium (p<0.001) and Serbia (p<0.001). Portugal´s distribution of sodium remained statistically significant from Belgium´s (p=0.013) and Serbia´s (p=0.007). Sweden´s distribution remained statistically significant to that of Belgium´s (p<0.001) and Serbia´s (p<0.001).

Table 20: Descriptive statistics on sodium in leavened bread only

| | Min | Max | Mean | Median | Sd |
|---|---|---|---|---|---|
| **All, n=214** | **55** | **1099** | **393** | **406** | **143** |
| Belgium, n=32 | 354 | 727 | 488 | 496† | 67 |
| Norway, n=58 | 119 | 519 | 307** | 305 | 124 |
| Poland, n=53 | 126 | 710 | 428 | 411 | 83 |
| Portugal, n=13 | 55 | 610 | 328** | 290 | 194 |
| Serbia, n=14 | 107 | 725 | 511 | 510† | 133 |
| Sweden, n=44 | 62 | 1099 | 377* | 352 | 173 |

** denotes that mean is in compliance to FSA´s target average for sodium in bread and roll products. In 2012 this target was 400 mg/100 g in 2017 360 mg /100 g. *denotes in compliance with 2012 targets only.

†denotes that 50% or more of products are above FSA´s maximum sodium targets for bread and rolls, (450 mg/100 g in 2017, no maximum target was set in 2012)

Figure 9 shows the samples spread of sodium in bread for all countries. Noted are Belgium and Serbia´s short interquartile ranges and short whiskers. The concentration of their samples are higher in sodium in comparison to the other countries. The two countries hold the highest median values, and the majority of their products remain close to their medians.

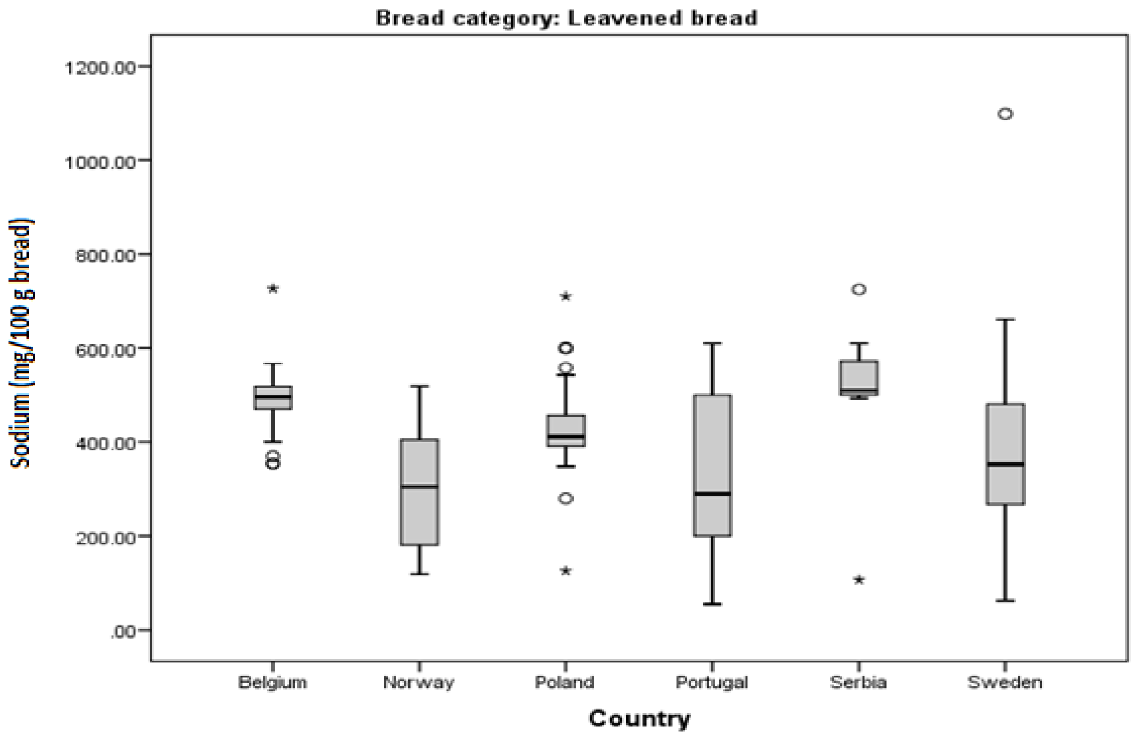


Figure 9: Sodium content, leavened bread category only, by country (p<0.001)

### 6.3.4 Comparison with nutritional recommendations

**Comparison to the UK´s FSA target average and maximum sodium values**

As addressed in the methods section, the UK´s FSA salt reduction measures have set targets for sodium amounts in bread. Target maximum levels for a bread product is set at 450 mg. Target average of products in 2012 was 400 mg/100 g bread, in 2017 it lowered to 360 mg. Salt reductions are recommended to happen gradually (stealth reduction), for this reason targets from both years will be assessed.

Table 20 highlights countries with sample results in or out of compliance to the UK´s FSA´s salt reduction recommendations. Fifty percent or more of the bread products from the leavened bread samples from Norway, Poland, Portugal and Sweden meet the maximum sodium set target. Samples from Norway and Portugal meet the average sodium target for both 2012 and 2017 standards; Sweden meets the 2012 target.

**Application of sample median sodium values per serving of bread**

Serving sizes of bread will vary depending on bread type. To provide the best practical application, only the results from *leavened bread* were included, serving size standard of 50 g. Outliers were found among the bread sample distribution, however median and mean results remained nearly identical globally and across countries. Due to noted similarities, mean values were used to estimate the average amount of sodium each serving (50 g) of bread yields per country. Results are calculated in Table 21.

**Estimation of sodium intake from bread by country**

Table 21 also provides a look at application of the mean values from the samples to the noted average bread intakes from each country (specified in the background section of this paper). If total bread consumption were procured from the *leavened bread* category, estimates of the percentage of sodium allotment that bread accumulates could range from 16-28% of total daily sodium allowance.

Table 21: Estimates of potential sodium contribution from leavened bread

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | All |
|---|---|---|---|---|---|---|---|
| Mean sodium (mg) per 100 g bread, all samples | 488 | 307 | 428 | 328 | 511 | 377 | 393 |
| Mean Na (mg) per 50-g serving size | 254 | 154 | 214 | 164 | 256 | 189 | 197 |
| Percent of sodium allotment per serving* | 12.7% | 7.6% | 10.7% | 8.2% | 12.8% | 9.4% | 10.0% |
| Average bread intake g/day[a] | 107 | 184 | 124.6 | 105 | ~ | 87 | 121.5[b] |
| Daily sodium (mg) intake from bread[c] | ~ | 660 | ~ | 513 | ~ | 343 | ~ |
| Potential sodium (mg/day) intake from bread[d] | 522 | 567 | 533 | 344 | ~ | 328 | 422 |
| Potential % daily sodium allotment[e] | 26% | 28% | 27% | 17% | ~ | 16% | 22% |

a) From most recent NFCS and HBS survey data (Appendix A). Not all average bread intakes come from same age groupings. Age brackets are as follows: Belgium: 18-64 year-olds; Norway: 18-70 year-olds; Poland: all ages; Portugal: 18-64 year-olds; Sweden: 18-80 year-olds. Estimates are not meant for comparison across countries, as estimated averages came from different surveys each using different years, methodologies and standards of reporting.

b) Average from five countries providing data

c) Estimates taken from country´s national food consumption surveys providing data on average sodium amounts coming from bread

d) Utilizing information from NFCSs and HBS on average bread intake per day per country and applied to the mean value of the samples studied from each country

e) Percent of sodium allotment occupied by the average bread intake (per country), when applying mean sodium values from bread samples available per country

## 6.4 Sugar in ready-to-eat breakfast cereal

Table 22 provides a summary of the breakfast cereal data. In total, there were 95 samples of breakfast cereals compared for their amounts of sugar. Belgium (n=24, 25%) provided the most samples and Serbia (n=3, 3%) provided the least. The samples were categorized mostly as *flakes, popped or similar (FPS)* (n=67, 71%), then as *muesli* (n=28, 29%)

Table 22: Count of ready-to-eat breakfast cereal items in sample

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | TOTAL |
|---|---|---|---|---|---|---|---|
| Total (n) number of breakfast cereal items | 24 | 21 | 10 | 11 | 3 | 26 | 95 |
| Percent of total breakfast cereal items | 25% | 22% | 11% | 12% | 3% | 27% | 100% |
| Number (n) *Flake, popped and similar* (*) | 18 (75%) | 17 (81%) | 8 (80%) | 10 (91%) | 2 (66.7%) | 12 (46%) | 67 (71%**) |
| Number (n) of *Muesli* (*) | 6 (25%) | 4 (19%) | 2 (20%) | 1 (9%) | 1 33.3%) | 14 (54%) | 28 (29%**) |

*Percent of breakfast cereal type within country
**Percent of breakfast cereal type within total breakfast cereal sample

### 6.4.1 Comparison of sugar in all ready-to-eat breakfast cereal samples across countries

There was no statistically significant difference between the breakfast cereal samples when separated by country. (Figure 10)

Table 23 shows some descriptive statistics of breakfast cereals from each country. The country with the lowest median of sugar was Serbia (6 g sugar/100 g cereal); the country with the highest was Belgium (21.8 g sugar /100 g cereal. The country with the greatest amount of *FPS* cereals was Belgium; Sweden had the greatest amount of *muesli* cereals.

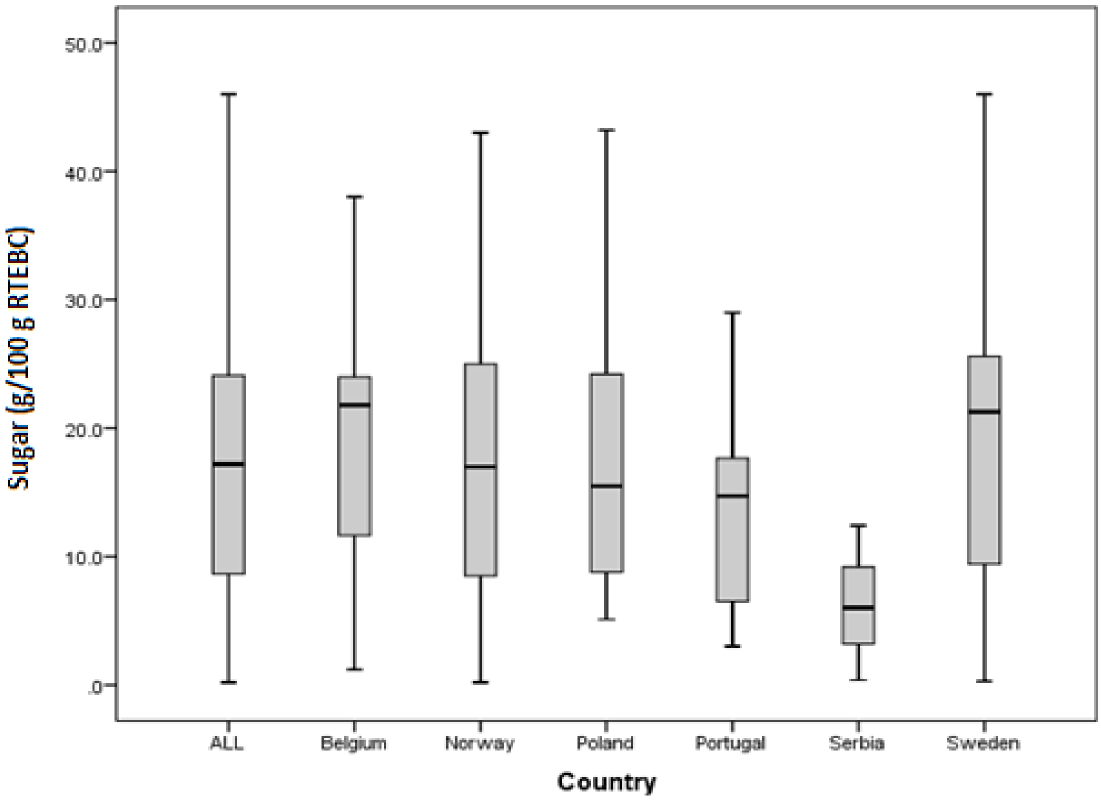


Figure 10: Sugar content of ready-to-eat breakfast cereal by country (p=0.236)

Table 23: Descriptive statistics of sugar (g) per 100 g of ready-to-eat breakfast cereal

| | Min | Max | Mean | Median | SD |
|---|---|---|---|---|---|
| **All Countries, n=93** | **0.2** | **46.0** | **17.7** | **17.2** | **10.9** |
| Belgium, n=24 | 1.2 | 38.0 | 19.4 | 21.8 | 9.7 |
| Norway, n=21 | 0.2 | 43.0 | 16.7 | 17.0 | 11.9 |
| Poland, n=10 | 5.1 | 43.2 | 18.8 | 15.5 | 12.8 |
| Portugal, n=11 | 3.0 | 29.0 | 13.9 | 14.7 | 9.0 |
| Serbia, n=3 | 0.4 | 12.4 | 6.3 | 6.0 | 6.0 |
| Sweden, n=26 | 0.3 | 46.0 | 19.2 | 21.3 | 11.2 |
| *FPS* All Countries, n=67 | 0.2 | 46.0 | 17.2 | 15.5 | 12.1 |
| *Muesli* All Countries, n=28 | 1.8 | 29.1 | 18.7 | 21.2 | 7.1 |

**FPS= flaked, popped and similar*

As fruit is a sugar source and therefore contributes to total sugar, a count by country of breakfast cereals containing fruit was made based on available information. Sweden has the most cereal samples known to contain fruit (n=12), Serbia the least (n=0). Figure 11 shows the count of breakfast cereals containing fruit or not by country.

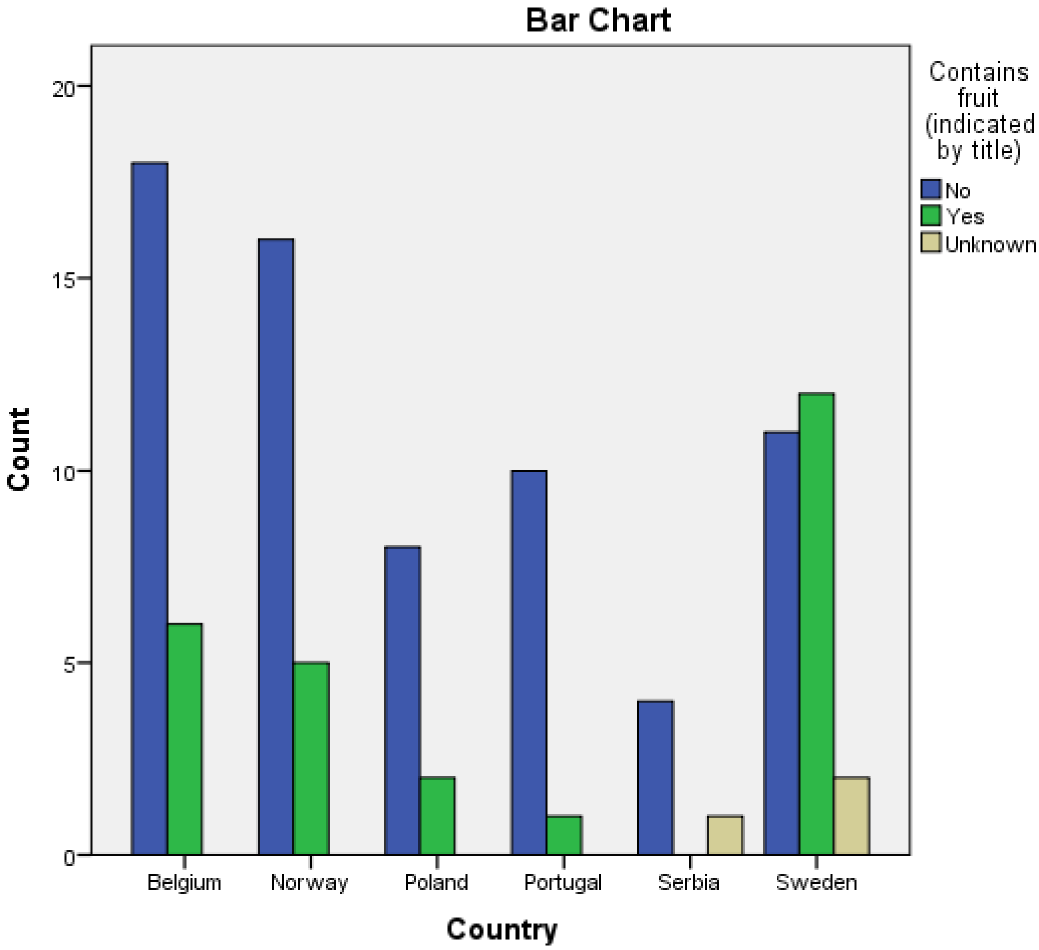


Figure 11: Ready-to-eat breakfast cereal count of items containing fruit, separated by country

### 6.4.2 Comparison of sugar among ready-to-eat breakfast cereal categories

Distributions of sugar by RTEBC category were similar (Figure 12). The median sugar values for *fps* (15.5) and *muesli* (21.150) were not statistically different, ($U$=1,091, $z$=1.249, $p$=0.212, n=95).

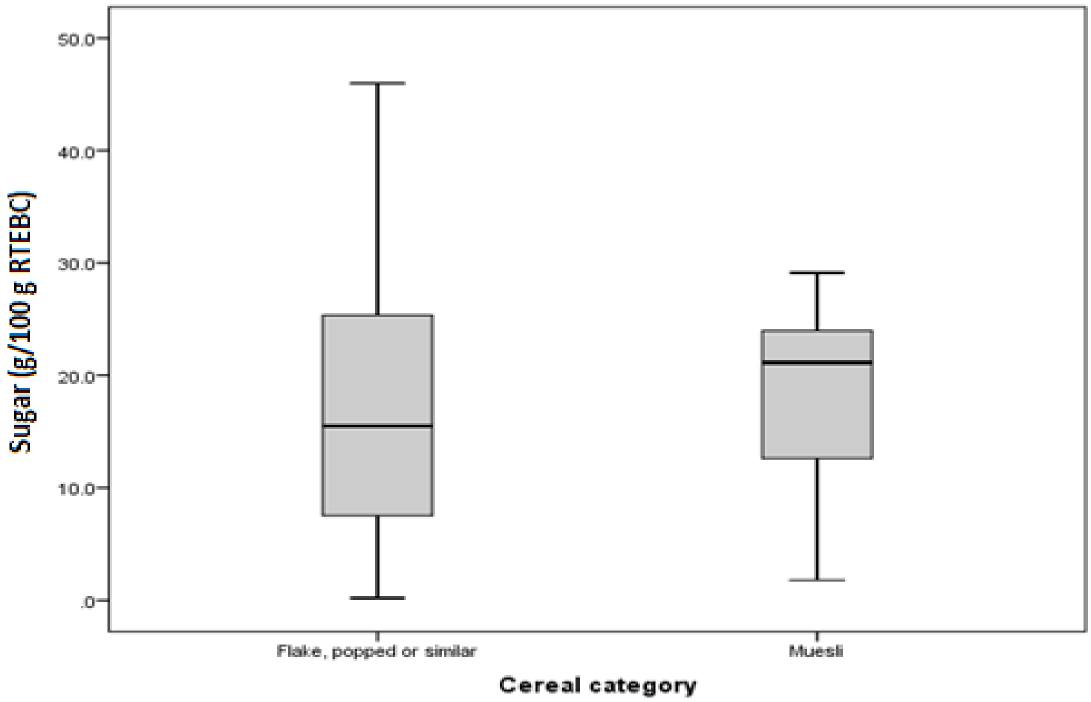


Figure 12: Variation of sugar by ready-to-eat breakfast cereal category, samples from all countries

### 6.4.3 Comparison of sugar in each RTEBC category across countries

There were also no statistical differences in distributions of sugar observed between countries when separated by RTEBC category. *Fps* ($\chi^2(5)=6.491$, p=0.261, n=67); *muesli* ($\chi^2(5)=2.510$, p=0.775, n=28).

### 6.4.4 Comparison with recommendations

**Comparison to the UK´s FoP nutrition label requirements**

Referencing median values of RTEBC by country (Table 23), 50% or more of all samples have sugar values well above the amount required (< 5 g sugar) to obtain a “green” color coding on the FoP nutrition label, which is significant of a healthier choice.

**Application of sample mean sugar values per serving of RTEBC**

As addressed in the methods section, the average recommended serving of a breakfast cereal is 35 g. Using mean values, estimations were calculated for average amount of sugar that one serving of breakfast cereal might contain (Table 24). Data values did not separate free sugars from total sugars. Application to recommended daily allotment is based on the general recommendation of 90 g sugar per day.

### Estimation of sugar intake from RTEBC by country

Application of the mean values from the samples to the noted average RTEBC intakes from each country (specified in the background section of this paper) are also presented in Table 24. Based on these estimates and our generated mean values from each country´s sample, the percentage of sugar allotment that RTEBCs accumulates could range from 0.9 to 2.5% of total daily recommended sugar consumption.

Table 24: Estimates of potential sugar contribution from ready-to-eat breakfast cereal

| | Belgium | Norway | Poland | Portugal | Serbia | Sweden | All |
|---|---|---|---|---|---|---|---|
| Mean sugar (g) per 100 g of RTEBC, all samples | 19.4 | 16.7 | 18.8 | 13.9 | 6.3 | 18.6 | 17.7 |
| Sugar (g) per 35-g serving | 6.8 | 5.9 | 6.6 | 4.9 | 2.2 | 6.5 | 6.2 |
| Percent of daily sugar allotment per serving* | 7.5% | 6.6% | 7.3% | 5.4% | 2.4% | 7.2% | 6.9% |
| Average RTEBC intake g/day[a] | 6 | - | 4.3 | 15 | - | 12 | 9.3[b] |
| Potential sugar (g/day) intake from RTEBC[c] | 1.2 | - | 0.8 | 2.1 | - | 2.2 | 1.6 |
| Potential % of daily sugar alloment* (from 90g)[d] | 1.3% | - | 0.9% | 2.3% | - | 2.5% | 1.8% |

*Percent daily sugar "allotment" based from European Commission recommendations of 18% of energy intake applied to 2000 calorie level diet, yielding 90 g sugar(51).

a) From most recent NFCS and HBS survey data (Appendix A). Not all average RTEBC intakes come from same age groupings. Age brackets are as follows: Belgium: 18-64 year-olds; Poland: all ages; Portugal: 3-64 year-olds; Sweden: 18-80 year-olds. Estimates are not meant for direct comparison across countries, as estimated averages come from different surveys each using different years, methodologies and standards of reporting.
b) Average from four countries providing data
c) Utilizing information from NFCSs and HBS on average breakfast cereal intake per day per country and applied to the mean value of the samples studied from each country
d) Percent of sugar allotment occupied by the average RTEBC intake (per country), when applying mean sugar values from RTEBC samples available per country

# 7. DISCUSSION

The overall purpose of the present study was to characterize and analyze variations across six countries between saturated fat and sodium in cheese, sodium in bread, and sugar in RTEBCs. Along with characterization, the objective was also to view, where possible, if product averages are congruent with recommended levels. Variations were noted in all food types and possible explanations will be explored.

## 7.1 Variation of saturated fat in cheese

As a whole, cheese products are high in saturated fat. Through the color-coded FoP labelling system, greater than 5 g of saturated fat per 100 g of any given food item is marked in red and considered a cautionary food item (109). All countries have 50% or more of their cheese products well above the 5-g limit. Cheese types that offer more low to medium (green to amber color-coding) values are processed and some fresh type cheeses, as they have a greater ability to be reformulated to produce lower fat values. A ripened cheese and other natural cheeses have a lesser capability of reformulation to meet lower saturated fat coding criteria, as the process presents many challenges. The exclusive source of fat and saturated fat in natural cheese is derived from the cream portion of the milk. In order to reduce this, milk fat may be substituted with protein and/or the cream may be removed by centrifugal separation. An additional obstacle is food safety. Lower fat traditional cheeses have a higher moisture content and require the addition of more sodium in order to control harmful microorganism growth (113).

The grouping of cheese categories into *fresh uncured cheese*, *processed cheese and spreads*, *ripened cheese* and *brined cheese* did prove to be indicative of saturated fat and sodium values in some respects. As a whole, ripened cheese contains more saturated fat than fresh or processed cheese types, and fresh uncured cheeses contain less sodium than do other varieties. These differences are also supported by recommendations from the *Keyhole* voluntary labeling system, where fresh cheese is required to have a lower total fat and sodium content (maximum 5% total fat and 0.35 g sodium/100 g) than other cheeses (maximum 17% fat and 0.05 g sodium/100 g) for authorization of label use (96).

In the cheese sample as a whole, Belgium contained more cheese products with higher amounts of saturated fat than Portugal and Sweden. This may have been due to percentage differences in varieties of cheeses, in that Belgium had a much higher percentage of *ripened cheeses* (77%) when compared to the others (55%, 39%, respectively). Ripened cheese has a significantly higher variation in saturated fat values than *fresh uncured cheese* and *processed cheese and spreads*. When just ripened cheeses were compared across countries, significant differences were found between Belgium and Portugal only. This implies that differences with Sweden were most likely due to Belgium´s higher percentage of *ripened cheeses* among its sample, as there were no statistical differences in saturated fat in the other cheese categories when comparing across countries by multiple comparison.

Portugal´s sample of *ripened cheeses* contained more cheese products lower in saturated fat values in comparison to the sample from Belgium. In observation of the *ripened cheese* samples from each country (See Appendex C) several traditional cheeses are observered. Cheeses of Portuguese origin included samples such as "Flamengo" (in several different fat varieties), and regional cheeses such as Alcobaça, Alverca, Azeitão, Ilha, and Serpa. These cheeses, when compared to that of Belgium´s selection of ripened cheeses originating from Belgium (Affligem, Chimay, Moerengoud and Old Brussel) and other neighboring countries, [Bou d´Fagne (Netherlands), Chamois d´Or (France), Cambozola (Germany), Explorateur (France), Maaslander (Netherlands), Marquis (France), Peyrigoux (France), Suprême des Ducs (France), Tommette de Savoie (France), etc] have substantially less saturated fat.

Norway´s selection of *fresh uncured cheese* contained more products higher in saturated fat than all other country´s selections. Reviewing the selection of cheese in each sample, Norway´s included several high fat cream cheeses and traditional whey cheese varieties, which typically have higher saturated fat contents than other *fresh uncured cheese* varieties. Portugal, for example, had lower fat varieties including quark cheeses as well as its traditional "Requeijão" cheese, which are substantially lower in saturated fat than Norway´s traditional whey cheese and general cream cheese.

Within the cheese samples from each country, several traditional cheeses were identified, inferring that cultural norms and practices in cheese product selection is a potential influencing factor on variation in distribution of saturated fat values. Innovations, (e.g. saturated fat reduction) of traditional foods such as cheese present challenges for manufactures in consumer acceptance as consumers tend to prefer what they are accustomed to (114). Traditional foods are appealing to many Europeans as they give importance to natural content, however many Europeans also view traditional foods as being unhealthy and negatively associated with weight control (115). Health benefits and weight control is a possible angle of which to promote innovations to traditional foods.

Cheese from all studied countries generated a median of 8.3 g of saturated fat per 50-g serving, accounting for 37.7% of estimated daily saturated fat allotment. Sweden and Portugal presented the lowest values, Belgium and Norway the highest. Although not accurate to make direct comparisons across countries in average amounts of cheese consumption, (due to the use of different years, surveys and methodology of reporting results) it would appear that out of the five countries providing cheese consumption data, Norway´s population consumes the most (41 g/day). The average and median saturated fat amounts are highest in Belgium. Based on consumption amount and estimated saturated fat values from the Norwegian cheese samples, it is probable that Norway would be most impacted (out of the five countries with approximated daily cheese intakes) by cheese in their daily saturated fat totals. No information was available on cheese intake in Serbia. Further research is needed to determine whether or not differences in impact on total saturated fat intake from cheese per population is significant.

## 7.2 Variation of sodium in cheese

The average amount of sodium in one 50-g serving of cheese among all countries was 307 mg accounting for 15.5% of total sodium allowance. Results are in agreement with typical estimated amounts of sodium in cheese as a whole, which is approximately 310 mg per 50-g serving (5). The distribution of all cheese products across all countries did not yield statistical differences.

As addressed in section 7.1, the grouping of cheese categories did prove to be indicative of sodium values. When comparing *ripened cheese* only, Poland and Portugal have more products with higher levels of sodium than Sweden and Norway.

At least 50% of the ripened cheese products from the samples of Portugal are above FSA´s 2012 and 2017 target maximum sodium levels of 800 mg for “hard pressed” cheeses. The average amount of sodium in Portugal and Poland´s cheese samples also do not meet 2012 or 2017 FSA target averages for “hard pressed” cheeses (111).

For *fresh uncured cheeses*, 50% or more of Norway´s products exceed the FSA´s 2012 and 2017 maximum sodium targets (330 and 270mg/100g, respectively) for “fresh cheese”. Belgium and Poland are the only countries that present mean values of *fresh uncured cheese* samples in compliance with target average sodium levels in fresh cheese products for 2012 and 2017 (220 and 200 mg/100g, respectively).

In the processed cheese and spreads category, Portugal, Serbia and Norway all have 50% or more of their sample´s products above the FSA´s maximum sodium targets for “processed spreads” and “processed other” for 2012 and 2017. (Processed spreads: 900 mg/100 g in 2012 and 720 mg/100 g in 2017; processed other: no target in 2012, 800 mg/100 g in 2017) The mean values for the samples of all countries were not in compliance to FSA´s target average of sodium in “processed spreads” products nor in “processed other”. In 2012 and 2017, target average for “processed spreads” remains 650 mg/100 g. For “processed other”, targets were at 800 mg/100 g in 2012 and 650 mg/100 g for 2017.

Using the FoP labelling system, at least 50% of all cheese products coming from the samples of Belgium, Poland and Portugal have sodium levels higher than 590 g per 100 g of cheese, and would be labeled as red, cautionary items.

Although there were no statistical differences in the distribution of sodium across countries, there were differences in countries meeting target standards set by the UK´s

FSA. Across all cheese categories, Portugal scored higher than recommended target levels. Norway´s *fresh uncured cheese* and *processed cheese and spreads* selections also exceed target levels

Applying the available data of cheese intake levels from each country (except Serbia) with each country´s mean sodium value from the selections of cheese provided in our sample, an estimated potential of sodium contribution from cheese was calculated and compared with maximum daily sodium recommendations. Approximated cheese intake levels represented varying age divisions across countries; therefore, comparisons between countries are not feasible. Three of the country´s national food consumption surveys gave results on the contribution of sodium derived from the cheese consumed (78,80,81); the present study´s results are estimating potential contribution of sodium from cheese, based on available food products and intake levels. Individually, comparisons between the approximate daily amount of sodium consumed from cheese and the present study´s estimates of potential contribution from available cheese products, fared well with the results from each country´s NFCS, with differences between just 18 to 34 mg.

Studies provide evidence that reduction of sodium in cheese as a whole is feasible. As cited in the literature review, a reduction of 10-25% sodium is not noticed by the consumer (69). In addition, there appears to be a range of salt acceptance levels in specific types of natural cheeses (68). This range, when using the lower-end of recommendation of sodium while still maintaining an acceptable product, is up to 4 g of salt per kilogram of cheese in difference, in the examples given. This would account for a difference of approximately 157.36 mg of sodium per 100 g of cheese. In addition, some cheeses go well above these recommended ranges for their cheese type. As a *Rachlette* cheese sample within the present study´s sample was found to have 212 mg more sodium per 100 g of cheese than its upper recommended range value. More studies comparing specific types of cheeses and their lowest acceptable salt range are needed as the present study compared among defined cheese categories rather than specific types.

Also worth noting is sodium level as it compares to saturated fat. Typically, there is a noted inverse relationship among cheeses with total fat (and therefore saturated fat) values and sodium, in that if fat is reduced in a cheese product, sodium then increases. The present study did not compare fat as it relates to sodium specifically; however, study results showed Portugal as providing *ripened cheese* samples with the lowest saturated fat amount, but the same sample was also highest in sodium when compared to the other five countries. Studies have noted reduction in the intensity of salt with lower fat cheeses (113,116,117), providing evidence that with cheese, salt is difficult to reduce in conjunction with fat. Substitution of SFA with mono or polyunsaturated fatty acids has been explored in dairy products (118). Further studies are needed to access its substitution on overall impact in CVD markers as well as its compatibility in salt intensity perception and potential for sodium reduction.

## 7.3 Variation of sodium in bread

Due to limited *unleavened flat bread* samples (n=15) and to allow for comparison of the most similar in products, more consideration was given to the *leavened bread* category. From the samples studied, Norway offered more *leavened bread* products lower in sodium than did the selections from Poland, Belgium and Serbia. Portugal´s sample also offered more lower sodium *leavened bread* products in comparison to Serbia.

Norway and Portugal had the lowest mean values of sodium (307 mg and 328 mg per 100 g *leavened bread*, respectively). Serbia and Belgium had the highest (511 mg and 488 mg, respectively). The average 50-g serving of bread from the samples of Serbia and Belgium contributes to approximately 13% of total daily allotment of sodium. In Belgium where estimates were 107 g of daily bread intake per persons 15-64 years old, bread, based on this estimate, could account for 26% of total daily allotment of sodium, provided choices of bread came from the *leavened bread* category. If Belgium´s *leavened bread* selection was equivalent to that of Norway´s, Belgium could reduce this percentage to 16% (Norway´s mean of 307mg/100 g bread * 107 g bread consumed daily in Belgium / 2000mg sodium allotment).

*Leavened bread* samples from Norway, Portugal and Sweden presented the best scorings in sodium compliance to the FSA´s target average and maximum sodium levels. Serbia and Belgium had mean bread sodium levels above FSA target average levels. Gradual sodium reduction in bread, up to 25%, can be achieved without being noticed by the consumer (119). If Serbia´s and Belgium´s mean sodium values were reduced by 25%, they would be in compliance with FSA´s 2012 target levels.

If total bread consumption were procured in each country from the *leavened bread* category, estimates of the percentage of recommended maximum sodium intake that bread occupies could range from 16-28%, among different population ages. This estimation seems accurate when compared to results from national food consumption surveys. In Norway, bread accounted for 22% of total sodium intake which was approximately 3 g sodium per day (78). If applied to the WHO recommended sodium levels, the entire bread group would account for 33% of Norway´s daily sodium allotment. The present study focused on leavened bread and similar items, it did not include rusks, crisps or crackers (due to a limited sample size), which are included in the bread group and tend to have more sodium.

Portugal and Belgium have legislation limiting the amount of sodium allowed in bread, both allowing up to 550 mg per 100 g bread. Portugal had 2 out of its 13 samples of *leavened bread* (15%) containing sodium values over this amount, and Belgium had 1 out of its 33 samples (3%) over 550 mg sodium. Belgium´s legislation does not enforce sodium restrictions on imported products(83).

Both Norway and Sweden use a voluntary label system, the *Keyhole*, in which bread products able to use this symbol are required to contain less than 500 mg of sodium per 100 g of bread (as well as a certain amount of whole grain and fiber, and a maximum of 7% fat and 5% sugars). Only 3 out of 58 total *leavened bread* products from Norway (1.7%) contained a sodium value equal or greater than 500 mg, and 6 out of 43 from Sweden (14%). Voluntary label systems have been speculated to encourage manufactures to produce more products of healthier varieties in general (120).

The largest health gains have been noted to result from mandatory reductions in sodium rather than voluntary programs (121). The results from the present study suggest that each country may have unique and varying factors that influence willingness for reductions. Belgium, for example, complies better than Portugal with its mandated legislation, but most of Belgium´s bread products are at the maximum levels allowed. Portugal, with the same legislative restrictions on sodium in bread, provides products with a varying amount of sodium, most of which are much lower in sodium than the maximum permitted. Countries are encouraged to make salt reduction strategies unique to their population (24).

## 7.4 Variation of sugar in ready-to-eat breakfast cereals

Variation of sugar in RTEBC exists when comparing across countries, however in direct comparison between countries variations were not significant. There was a large gap between average sugar in Belgium (19.4 g sugar/100 g cereal) and Serbia (6 g/100 g). Serbia had the least amount of samples (n=3) of RTEBC which included cornflakes, oat flakes and puffed rice, all considered low to medium sugar options of RTEBCs. Belgium had 6 samples of RTEBC known to contain fruit, accounting for approximately 25% of all cereals, but other countries, such as Sweden (46%) had a higher percentage of samples known to contain fruit and a slightly lower sugar mean (19.2). From this perspective, it would appear that RTEBCs from Belgium´s sample contain more free sugars.

Both the Keyhole and UK´s FoP labelling aid in nutritional scoring for RTEBC items. The *Keyhole* requirements for breakfast cereals and muesli allow a maximum of 13% sugar, along with other recommendations for at least 6 g of fiber, a maximum 0.05 g salt, 7 g fat per 100 g and at least 50% whole meal based on dry matter. Full application of the *Keyhole* requirements for breakfast cereal was not feasible due to the missing information of whole grain amounts. Assessing just the sugar aspect of these requirements, all countries´ samples except Serbia´s have 50% of their RTEBC products containing more than 13% sugar.

Using the UK´s FoP sugar level criteria, 50% or more of all cereal products from all countries would yield an amber or red code label denoting cautionary or high sugar products.

When applying average daily consumption amounts of cereal per country to average sugar contribution from the RTEBC in our sample, it would appear that the RTEBC´s sugar contribution is negligible in the average person´s diet, consuming approximately 1.8% of daily sugar allotment. This impact estimation may be skewed due to the full population being represented, as children tend to eat more RTEBC than do adults or elderly people. In Portugal, children less than 10 years of age consume 29 g of cereal per day, compared to an average of 10 g per day in adults 18-64 years old, and 4 g per day in adults aged 64-84 years (79). A study on the available selection of RTEBC from these countries and potential sugar intake impacts for children specifically is warranted.

## 7.5 Strengths and limitations of present study

One strength of the study is the robust nutritional data that a FCT provides, especially from the four databases EuroFIR (representing Poland, Serbia and Sweden), Nubel (Belgium), PortFIR (Portugal) and Matveretabellen (Norway). All highly accredited for accurate data and standardization. Another was the division of food items into specific food categories for a more accurate comparison.

The study did include a few limitations. One limitation was the availability of recent data for Poland; it´s most recent available data is from 2005. All other counties provided food composition database versions within the past four years.

Secondly, the data is not a true representative sample, rather a convenience sample in that it represents the foods most commonly consumed from the foods available on the market. Although a series of guidelines are provided, there is no specific protocol on inclusion criteria for FCTs; however, each county from this study confirmed that commonly consumed items typically derived from national food consumption surveys (NFCS) are deciding factors in which foods should be included. Not all countries have the same collection and analysis methods for their NFCS, nor are they completed in the same years to allow for equal comparisons. A comprehensive or exhaustive database would have been ideal, but this is not realistic due to the vast number of growing food products and possible variations of them. However, this sample provides the best available data for a comparison of commonly consumed items, supported by the robust scientific analysis requirements of a food consumption survey.

In accessing average intakes of each food item per country, NFCS were referenced where available. Serbia and Poland did not have available NFCSs for reference, a recent HBS was used for Poland and a health survey for Serbia. Norway, Portugal and Belgium utilized the methodology of the EU menu process in their NFCSs, but results were reported differently, using different food and age groupings across surveys. Furthermore, data collection was completed in different years for each country. Due to these limitations, potential impact based on population consumption of a food item cannot be directly compared across countries.

Missing data for trans fatty acids (trans fat), was another limitation of this study. All food items have the potential to have synthetically added trans fatty acids, and trans fat does occur naturally in cheese. Efforts in lowering saturated fat in cheese would also lower naturally occurring trans fatty acids as they appear together.

The study's design accessed specific nutrient values and did not compare to other nutritional factors such as caloric content or fat content in relation to sodium, sugar or fiber. Nor was it able to access the use of healthier ingredients, such as whole grain verses refined grain ingredients.

The overconsumption of sodium, sugar and saturated fat in the diet provides a very complex and intricate web of contributing factors. This study took a simplistic, straightforward approach in the characterization and comparison of equivalent food products without full consideration to all possible influences. Therefore, the results from this study should be viewed as exploratory, and more specific studies should be completed on each of its findings.

# 8. CONCLUSION AND RECOMMENDATIONS

A study such as this provides a clearer description of a small component to the complex ecological framework influencing an individual´s diet. The uniqueness of our sample was that it was a combination of two influencing factors, foods available on the market and foods most commonly consumed. This allowed for both a glimpse of each country´s physical environment of foods available with a mixture of possible individual, culture or policy and legislative components potentially influencing food choice.

In characterizing the food items across countries, results remained more or less consistent with typical averages of saturated fat and sodium in cheese, sodium in bread and sugar in ready-to-eat breakfast cereals. Differences were observed among our sample across countries. Belgium's cheese samples contained higher amounts of saturated fat than Portugal's and Sweden's samples. These differences appeared to be partially the result of the influence of traditional cheese products. Norway, Portugal and Sweden contained bread samples with the least amount of sodium, this could be an influence of the voluntary *Keyhole* FoP labelling system, used in both Norway and Sweden, which encourages products to contain less sodium (among other standards) for its use. Countries with the same food legislation (bread legislation in Portugal and Belgium) yielded different product results and nutritional scoring, further emphasizing potential cultural uniqueness among countries. These are all areas which should be explored further.

The utilization of specific food categories proved to provide the best comparison of like items for the cheese group, as *fresh uncured cheeses* have significantly less saturated fat and sodium values than other cheese categories. For the bread and RTEBC groups, differences in saturated fat, sodium and sugar did not prove to be sufficient for separation into specific categories. However, if further research is pursued in this area, categorical separation may still be warranted as consumption levels of different types of bread or breakfast cereals may vary from population to population.

Direct comparison of each food item category across countries was able to further distinguish areas of difference across countries. With saturated fat in cheese, differences between countries were able to be directed to the *ripened cheese* and *fresh uncured cheese* categories. Noting that differences between higher saturated fat in *ripened cheese* items from Belgium as compared to Portugal should be explored more, as well as differences between higher saturated fat in Norway's *fresh uncured cheese* samples when compared to Portugal's. For sodium in cheese, reasons for differences in ripened cheese should be further explored in Norway as compared to the higher values from Portugal and Poland. For bread, it allowed further focus to the *leavened bread* category only. Further exploration should be given to the higher values of sodium from the *leavened bread* samples of Belgium and Serbia in comparison to Norway and Portugal.

The use of instruments of classification for food items remained congruent with findings from statistical difference measurements tests, but also provided further insight into each country's scoring of products, and potential areas of further exploration. For saturated fat in cheese, further information was highlighted concerning *fresh uncured cheese* samples from Belgium, Poland and Serbia in that 50% or more of their products had less than 5 g saturated fat per 100 g. For sodium in cheese, Portugal scored higher than recommended target levels for all cheese categories, and Norway scored higher than target values form *processed cheese and spreads* and *fresh uncured cheeses*. For Bread the countries of Norway, Poland and Portugal met all target lower level sodium goals.

From applying the knowledge of approximate food product consumption per country, a better approximation of impact was made, as each country's consumption habits are important in estimating the potential effect that changes in nutrients of a product might yield. Whether or not these differences influence total sodium, saturated fat or sugar intakes needs to be studied further.

With the evidence of statistical differences between food item samples across countries, the study did demonstrate that further reductions in mean sodium, saturated fat and sugar for food items as a whole may be feasible for some countries. This may be through means of "healthier" product promotion, consumer education, working with food manufactures, legislation or investigating other means to lower these values across products as a whole.

The present study´s focus was on measuring individual levels of saturated fat, sodium and sugar across countries. However, these are not the only components of a food item that influences an overall healthy diet and NCD risk. A study comparing and scoring all nutrients as a whole and as they compare to caloric density and wholesomeness of ingredients (e.g. whole grain versus refined flour, non-hydrogenated oils, etc) is recommended and may provide a more accurate conclusion of a product´s health scoring as it relates to saturated fat, sodium and sugar values.

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# Appendix A: National Food Surveys or Substitutes

## Belgium

BNFCS2014: The Belgium National Food Composition Survey conducted in 2014 was coordinated by the EFSA and played a part in the EU Menu project, whose goal is to establish harmonized methods and tools in conducting surveys in order to more accurately compare EU country results. In the BNFCS2014 study, 3200 Belgium residents aged 3 to 64 were randomly selected to participate and 37% completed all criteria. The study consisted of two 24-hour dietary recalls for each participant, assessed during two separate visits. During the time between the two visits (a two to four week interval) participants were asked to complete a food frequency questionnaire as well as a health questionnaire where in addition to general health questions, other diet and eating habit pertaining questions were asked. Data collection was divided equally over four seasons and throughout the days of the week to eliminate seasonal and day-to-day variation in food intake (86).

## Norway

Norkost 3: "Norkost 3 En landsomfattende kostholdsundersøkelse blant menn og kvinner i Norge i alderen 18-70 år, 2010-11" is a nationwide food consumption survey among men and women aged 18 to 70 years. Conducted in 2010-11, the diets of 862 men and 925 women were assessed by having the participants complete two 24-hour dietary recalls by telephone, with at least four weeks in between each assessment. They also answered a food frequency questionnaire. The survey was conducted by the Department of Nutrition at the University of Oslo, in cooperation with the Norwegian Food Safety Authority and the Health Directorate (78).

## Poland

Poland did not have an available national food survey for reference. Estimated intakes from Poland were derived from the latest Household Food Consumption and Anthropometric Survey from 2015. In these surveys, each participating household keeps quantitative food consumption records along with expenditures and incomes in a special journal for a month. Estimates are generally low, as only foods entering the home are counted; foods consumed away from home (such as food consumed in workplace canteens, bars and restaurants) are not counted (90).

## (Appendix A continued: National Food Surveys and Substitutes)

**Portugal**

IAN-AF: The National Food, Nutrition and Physical Activity Survey, 2015-2016 was conducted during a 12 month period. Participants aged 3 months to 84 years were randomly selected from the National Heath Registry, by multistage sampling, resulting in a total of 5,819 participants who completed the full survey consisting of two interviews (8-15 days apart) of 24-hour recall on their food intake. Participants also completed health questionnaires for physical activity and food security. In order to cover seasonal effects and regular day-to-day variation in food intake, interviews were distributed among participants over the four seasons and included all days of the week. Data collection procedures were adapted from the EFSA Guidance in view of the EU Menu methodology (79).

**Serbia**

Serbia does not have a national food survey; however, in the 2013 National Health Survey of Serbia, eating habits and nourishment of the population were included in the assessment. The survey´s target population was persons throughout all of Serbia 15 years of age and older. Eating habits represented a small portion of the survey and focused on such habits as daily intake of bread, fruits and vegetables, fish, milk and/or dairy products, type of fats used in preparing foods, consumption of breakfast, and the addition of salt to food. Also available was the YUSAD study, which used a seven-day household food consumption survey in which used an estimated and weighed food record with self-administered questionnaire (84).

**Sweden**

Riksmaten: The Swedish national food survey was conducted in 2010-11. It collected a representative sample of 5,000 individuals living in Sweden that were between the ages of 18 and 80 years old and received a total of 1,797 participants, both men and women. Participants reported everything they ate and drank during four consecutive days via web-based food diary and answered 50 questions. The survey utilized the format of the Swedish National Association of Foods, Livsmedelsverkets, which had been used in previous national surveys from 1989 and 1997/98 (81) .

*No national food surveys were available for the countries of **Poland** and **Serbia**

## Appendix B: Requirements for a keyhole label

**Cheese products:**

Fresh cheese and similar products with added flavoring are permitted a maximum of 5 g of fat per 100 g of fresh cheese, and a maximum sodium level of 0.35 g per 100 g fresh cheese product. Other cheeses, excluding processed cheese, are allotted a maximum of 17 g fat per 100 g and a maximum of 0.5 g sodium per 100 g cheese (96).

**Bread products**:

Bread products possessing a keyhole label must contain at least 25% wholemeal calculated on the basis of the dry matter of the product. Furthermore, a maximum of 7 g fat/100 g, 5 g total sugars/100 g, 0.5 g sodium/100 g, and a minimum of 5 g dietary fiber/100 g. Bread mixtures where only water and possibly yeast need to be added may be included, the above criteria applies to the finished product (96).

**Breakfast cereals and muesli**

Breakfast cereals and muesli that contain at least 50% wholemeal based on the dry matter of the product. A maximum fat content of 7 g/100 g. For sugars produced in pure form, a maximum of 10 g/100 g is allotted. Total sugar allotment may contain a maximum of 13 g/100 g. Sodium may contain a maximum of 0.5 g/100 g. The product must also contain a dietary fiber content of at least 6 g/100 g (96).

## Appendix C: FoodEx2 classification used for cheese [122]

| Cheese Category | FoodEx2 Core Terms | FoodEX2 Extended terms |
|---|---|---|
| Fresh uncured cheese | Fresh uncured cheese | cottage cheese, mascarpone, mozzarella, quark (e.g. fromage frais), cheese curd, ricotta, urda, skyr, boilie, burrata, chevre frais, clotted cream, crescenza (e.g. stracchino), juustoleipa, mizithra, triple crème, and cream cheese (e.g. philadelfia or boursin). |
| Brined Cheese | Soft brined cheese | feta, halloumi, telemea |
| | Firm brined cheese | ricotta salata |
| Ripened Cheese | Soft-ripened washed-rind cheese | epoisses, langres, limburger, munster, serpa, taleggio, vacherin mont d'or, wynendale |
| | Soft-ripened cheese with bloomy rind (white mould) | brie, camembert, chaource, chevre mould ripened, coulommiers, dunbarra, garrotxa, pouligny-saint-pierre, saga, saint marcellin |
| | Soft-ripened cheese veined with blue mould | bavarian blue, blue castello, blue de graven, cashel blue |
| | Soft-ripened cheese with white and blue mould | Cambozola |
| | Soft-ripened cheese with natural rind and other soft-ripened cheeses | banon, fleur de maquis, harzer, robiola |
| | Firm/semi-hard cheese | abundance, appenzeller, arzua ulloa, asiago, baita Friuli, beaufort, bica, bra, bundnerkase, butterkase, caerphilly, cantal, carrigaline, Cheshire, chimay, cornish yarg, cream Havarti, danbo, derby, double gloucester, doux de montagne, edam, esrom, fontina, gjetost, gouda, graddost, herrgardost, hushallsost, ibores, jarlsberg, kasseri, kurpianka smoked, Lancashire, lappi, Leicester, lubelski, maasdam, marechal, mimolette, morbier, morski, nagelkaas, nisa, nokkelost, oltermanni, ossau-iraty passendale, piacentinu, podlaski, prastost, provolone, raclette, raschera, saint nectaire, saint paulin, sao jorge, scamorza, smoked gouda, tete de moine, tetilla, tilsit, toma piemontese, tomme de savoie, torta del casar, Trappist, tronchon, turunmaa, vacherin fribourgeois, vasterbotten |
| | Hard cheese | aged graviera, cacio di fossa, canestrato pugliese, castelmagno, cheddar, coolea, emmental, evora, gruyère, hoch ybrig, iberico, idiazabal, kefalotyri, leyden, lincolnshire poacher, mahon, majorero, montasio, monte veronese, murcia, pecorino toscano, roncal, samsoe, schabziger |

## (Continued Appendix C: FoodEx2 classification for cheese) [122]

| | | |
|---|---|---|
| | Extra hard cheese | afuega'l pitu, bitto della valtellina, caciocavallo, comte, fiore sardo, formai de mut, grana padano, parmesan, manchego, parmigiano regiano, pecorino romano, ragusano, san simon, sbrinz, ubriaco, zamorano |
| | Firm-ripened blue mould-veined cheese | bleu d'auvergne, bleu de gex, cabrales, fourme d'ambert, gamonedo, gorgonzola, monje picon, roquefort, shropshire blue, stilton, valdeon |
| | Firm-ripened bloomy (white mould) or washed rind cheese | amarelo, ardrahan, buche de chevre, gubbeen, livarot, pont l'eveque, reblochon |
| | Firm-ripened cheese with added herbs, spices or other ingredients | |
| Processed cheese and spreads | Processed cheese, sliceable | |
| | Processed cheese, spreadable | |
| | Processed cheese wedges and similar | |

## Appendix D: FoodEx2 classification used for bread [122]

| Bread Category | FoodEx2 Core Terms | FoodEx2 Extended terms |
|---|---|---|
| Leavened Bread (and similar) | Mixed Wheat and Rye Bread | Rye-wheat bread, refined flour; Rye-wheat bread, wholemeal; |
| | Multigrain (not only rye-wheat) bread and rolls | |
| | Wheat bread and rolls, white (refined flour) | Wheat bread and rolls, white with maize; Wheat bread and rolls, white with potato; Wheat bread and rolls, white with rice; Wheat bread and rolls, white with soya |
| | Wheat bread and rolls, semi-brown | |
| | Wheat bread and rolls, brown or wholemeal | |
| | Rye only bread and rolls | Rye bread, refined flour; Rye bread, wholemeal; Pumpernickel |
| | Bread and rolls with special ingredients added | |
| | Sandwich bread (hamburger roll-type) | |
| Unleavened or flat bread (and similar) | Pizza base, cooked | |
| | Pita bread | |
| | Matzo | |
| | Tortilla | |
| | Roti | |
| | Chapati | |

## Appendix E: FoodEx2 classification used for ready-to-eat breakfast cereal [122]

| RTEBC Category | FoodEx2 Core Terms | FoodEx2 Extended terms |
|---|---|---|
| Flakes: Cereal flakes and similar | Processed mixed cereal-based flakes | |
| | Processed barley-based flakes | |
| | Processed maize-based flakes | |
| | Processed oat-based flakes | |
| | Processed rice-based flakes | |
| | Processed rye-based flakes | |
| | Processed wheat-based flakes | |
| | Extruded breakfast cereal products | |
| Popped: Popped Cereals | Barley popped | |
| | Popcorn (maize, popped) | |
| | Oat popped | |
| | Rice, popped | |
| | Rye popped | |
| | Wheat, popped | |
| Muesli: | Muesli and similar | Muesli plain<br>Muesli mixed |