Psychological characteristics associated with food avoidance behaviour and perceived (non-medically diagnosed) food intolerance in Australia

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ABSTRACT OF THESIS

Background

The aim of this thesis was to increase understanding of the discrepancy reported in the literature between perceived and medically diagnosed food intolerance. It also addressed the emerging trend in modern health decision making towards self-diagnosis and self-management of symptoms through the use of non-medically supervised exclusion diets. The hypothesis was investigated that specific individual-level psychological characteristics may underpin this phenomenon. Of particular interest was to explore factors, which are associated with the belief that reported symptoms are due to an intolerance or sensitivity to certain foods, in the absence of formal medical diagnosis. Underlying this was the question whether the psychogenic characteristics previously associated with perceived food intolerance in mostly clinical studies, which are thought to result in the misperception and misattribution of symptoms, could be generalised to people with perceived food intolerance in the general population.

Aims of the thesis
- To extend understanding of predictors of food avoidance in the Australian adult population beyond wheat avoidance to dairy avoidance. As part of that to investigate the symptoms, diagnoses and the potential for misattributions leading to self-prescribed food avoidance (Study 1).
- To explore the associated symptoms, the sources of diagnosis, and the psychological predictors of reporting of non-medically diagnosed (NMD) and medically diagnosed (MD) food intolerances in the Australian population (Study 2).
- To explore whether somatosensory amplification, described in previous research as a predisposing condition that leads to perceived food intolerance through the process of somatisation, is potentially a response to the

experiencing of very severe symptoms, rather than a cause of the condition and its symptoms (Study 3).

Results

Study 1 The avoidance of dairy appeared to rely substantially on a NMD connection between ingestion and symptoms, and was associated with increased reporting of past food intolerance. It was also predicted by worry about illness. These findings raised questions regarding the individual-level characteristics that may predispose individuals to attribute symptoms to the consumption of certain foods and, without a medical diagnosis, to subsequently label themselves as food intolerant. They also directed attention to the possible contribution of illness worry to the amplification and misattribution of these symptoms. Study 2 found that many adult Australians classify themselves as food intolerant without a supporting medical diagnosis. Having a NMD intolerance was associated with increased receptiveness to complementary and alternative medicine. Null effects for neuroticism cast doubt on the role of anxiety and negative affect suggested by clinical research. The found association of somatosensory amplification with both MD and NMD intolerances indicates that extra-vigilance in respect of symptoms is not peculiar to the latter. Study 3 revealed that the tendency to amplify symptoms and attribute them to a threatening disease was weaker in patients reporting food intolerance than those reporting IBS, with or without food intolerance. The findings support the view that severity and amplification of symptoms are markers of IBS-like symptoms and are not peculiar to the perception that one has a food intolerance.

Conclusions

The findings in this thesis supports the view that perceived food intolerance is unlikely to be a phenomenon, the result of psychiatric disturbance. Attributing adverse symptoms to specific foods is also unlikely to be due to psychosomatic reactions, of the kind observed in functional somatic syndromes. The origins of this behaviour appear to fall outside the

mainstream medicinal practice, with significant adherence to complementary and alternative medicine, and notable rejection of doctor's advice. This may reflect a tendency of people to exercise control over their health and to feel responsible for managing the risks of presumed food intolerance, without the need for medical evidence or oversight.

THESIS DECLARATION

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

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Yantcheva, B., Golley, S., Topping, D., & Mohr, P. (2016). Food avoidance in an Australian adult population sample: The case of dairy products. *Public Health Nutrition*, 19(9), 1616-23.
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Bella Yantcheva

Signed: _____   Date: _____

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Each and every person who has supported me, thank you.

Prelude

The overarching aim of this thesis was to increase understanding of the discrepancy reported in the literature between self-reported and medically diagnosed food intolerance and the emerging trend in health decision making towards self-diagnosis and self-management through the use of non-medically supervised exclusion diets. This thesis investigated the hypothesis that specific individual-level psychological characteristics may underpin this phenomenon, explaining why some individuals may be predisposed to associate a range of generic symptoms to the consumption of certain food items or components. Of particular interest was to increase understanding of the factors, which are associated with the belief that the symptoms they report are due to an intolerance or sensitivity to certain foods in the absence of formal medical diagnosis. Underlying this is the question whether the psychological characteristics previously associated with perceived food intolerance in mostly small clinical studies can be generalised to people with perceived food intolerance in the general population.

The first chapter of the thesis provides a review of the relevant literature, which includes an overview of the types of adverse reactions typically attributed to food, types of diagnosis (for allergy, and intolerance) and general food avoidance behaviour. It provides a detailed explanation of the meanings, definitions and current guidelines for the classification and diagnosis of adverse reactions, as well as of the distinction between allergies and intolerances.

The first chapter includes a literature review of Western population studies, which have reported prevalence figures of food allergies and intolerances, as well of small clinical and community studies, which have focused on psychological characteristics in people with food intolerance. It also discusses the main findings of the recent Australian population study on

wheat avoidance, which has raised important questions for addressing in this thesis. The chapter ends with the overall aims of the thesis.

The Introduction and Literature Review is followed by the Exegesis in Chapter 2. The exegesis provides an overview of the main research, a brief summary of the aims, methods, and results from each of the three conducted research studies, as well as how they link together. It also brings together the findings from each research paper and provides a conclusion in the context of their overall significance.

Chapter 3 through Chapter 5 represent the manuscripts of the three papers in the thesis. The first paper was published in the journal of Public Health Nutrition, the second paper was presented at the international 2015 European Health Psychology (EHPS) conference in Cyprus, and was submitted for publication to the journal of Public Health Nutrition, and the third paper was presented at the 2016 EHPS conference in Aberdeen, Scotland.

The sixth and final chapter provides a summary of the results from each of the papers, and a discussion of the implications and significance. The sixth chapter also addresses the limitations of the research and provides suggestions for future research. The thesis concludes with a list of references for all chapters.

Chapter 1: Introduction and Literature Review

1. **Adverse reactions to food and food avoidance behaviour**

Past research has indicated that physical complaints (chest pain, fatigue, dizziness, headache, back pain, insomnia, weight loss, cough), including those thought to be related to foods (constipation, diarrhoea, abdominal pain), are very common in general practice or hospital outpatient clinics (Kroenke & Mangelsdorff, 1989) yet more than half of reported symptoms remain unexplained or of unknown organic, physiological aetiology (Kroenke, 1989; Nimnuan, Hotopf, & Wessely, 2000). Despite the lack of pathological findings, distressing symptoms are the most frequent reason for persistent and repeated visits (Kroenke, 1989), and dissatisfaction with the outcome of and treatment provided by the conventional medical system (Barnes, Powell-Griner, McFann, & Nahin, 2004). Symptoms without objective organic disease are often perceived as being related to intake of particular foods or food components (Peveler, Mayou, Young, & Stoneham, 1996; Monsbakken, Vandvik, & Farup, 2005) and thought of as either being caused by allergy or intolerance to that food or as subsidiary symptoms of other syndromes, for example dyspepsia (also known as indigestion or upset stomach) (Peveler et al., 1996).

Existing research in the behavioural literature has directed attention to individual-level characteristics that may predispose some individuals to attribute distressing symptoms to the consumption of certain food items or components (Lied et al., 2011; Lillestøl et al., 2010; Berstad, Arslan, Lind, & Florvaag, 2005; Bell, Schwartz, Peterson, & Amend, 1993; Peveler et al., 1996; Lind et al., 2010), to the subsequent practice of non-medically supervised exclusion diets, as well as to the potentially adverse health

outcomes resulting from these practices (Marklund, Ahlstedt, & Nordstrom, 2004; Teufel, et al., 2007; Hallert, et al., 1998; Long, et al., 2010). However, this research has mostly been confined to clinical samples from mostly allergy clinics and its findings have not generalised to the few community or general population samples in which this issue has been investigated (Knibb, et al., 1999; Peveler, Mayou, Young, & Stoneham, 1996; Monsbakken, Vandvik, & Farup, 2005). In addition, this research has focused predominantly on the role of psychogenic factors, such as neuroticism, anxiety, negative affect and cognitive bias, in the possible misperception and misattribution of symptoms.

A recent study by Golley, Corsini, Topping, Morell, & Mohr (2015), on the motivations for avoiding wheat consumption in Australia, has become of seminal importance to the framework of this thesis. This study, which explored the avoidance of wheat for the control of adverse symptoms in a population sample, questions the central role of neuroticism and anxiety-related traits, suggested by previous research (Lied et al., 2011; Lind et al., 2005; Lillestøl et al., 2010; Pearson, Rix, & Bentley, 1983; Berstad, et al., 2005; Bell et al., 1993; Rix, Pearson, & Bentley, 1984; Knibb et al., 1999; Lind et al., 2010). Golley at al. (2015) found that symptomatic food avoidance was not predicted by neuroticism, illness worry or illogical reasoning and instead appeared to be influenced substantially by non-medical sources, increased receptiveness to complementary medicine and lesser receptiveness to conventional medicine.

Before proceeding further, it should be noted that food avoidance behaviour, explored in the study of Golley et al. (2015) and perceived food intolerance, subject of the clinical research mentioned above, do not necessarily represent manifestations of the same phenomenon. Although they both may be behaviours for control of adverse symptoms, a perceived intolerance is a particular attribution of a symptomatic state and indicates the response of

only those who avoid consumption of a certain food because of symptoms they associate with that food. Food avoidance behaviour, except for symptom-control (which may not be related to food, for example for high blood pressure control), may also be practised because of other non-symptom-related reasons, such as body weight management, family history of certain conditions, personal taste or preferences.

2. Adverse reactions to food

The following section will outline what is meant by adverse food reactions, including definitions, classifications and various methods of diagnosis. Of key importance is the distinction between food allergy and food intolerance, terms often perceived to have identical meanings (Stein, 2009).

### 2.1. Classification and Diagnosis

The umbrella term "adverse food reaction" is often used for any reaction following the consumption of food or a food substance. Adverse food reactions have been classified as toxic and non-toxic reactions (Committee on Toxicity of Chemicals in Food, 2000; Patriarca et al., 2009) (See Figure 1). Toxic substances, (such as histamine in scombroid fish or bacterial toxins in food), may be naturally present in foods and could result in toxic food reactions, or they may be added during food preparation by contamination (Committee on Toxicity of Chemicals in Food, 2000). Guidelines published by The European Academy of Allergy and Clinical Immunology (Johansson et al., 2004) for the classification and diagnosis of food allergy and food intolerance propose that when presence of immunological mechanisms has been established an adverse food reaction should be referred to as "food allergy". Also called a classic immune reaction, this is considered a reaction

where a protein is not recognised as safe (an antigen) by the immune system. Where the role of Immunoglobulin E (IgE) has been acknowledged, the exact term to be used is "IgE-mediated food allergy" (Johansson et al., 2004). In an IgE-mediated reaction, the specific IgE antibody sticks to mast cells and activates the release of pro-inflammatory chemicals (histamine), which provokes the symptoms of classic allergic reactions (e.g., rashes, difficulty breathing, hives, vomiting). IgE antibodies bound to cells can remain in the tissue for a long time, where they wait to meet the allergen, a process referred to as "sensitisation" (Arshad, 2002).

Other reactions, often referred to as "non-allergic food hypersensitivity" (Johansson et al., 2004), will be referred to throughout this thesis as "food intolerance" (Skypala, 2011). These reactions are non-immunological, having instead enzymatic, pharmacological or unknown causes (Skypala, 2011; Patriarca et al., 2009). The absence of IgE production in these food reactions has been clearly established (Skypala, 2011). A number of studies have investigated a potential immunological basis of non-IgE-mediated reactions, and have evaluated a possible role of Immunoglobulin G (IgG) tests in the diagnosis of food hypersensitivity (Vance et al., 2004; Zuo et al., 2007). However, it has been indicated that raised IgG levels relate to the level of consumption of a particular food, rather than indicate a hypersensitivity to that food (Vance et al., 2004). No correlation has also been found between the level of food-specific IgG antibodies and symptom severity in studies of dyspeptic or IBS patients (Zuo et al., 2007).

The classification of adverse reactions to food is presented in Figure 1 (Committee on Toxicity of Chemicals in Food, 2000; Skypala & Venter, 2009; Johansson et al., 2004).

Figure 1. Classification of adverse reactions to food (Skypala & Venter, 2009)
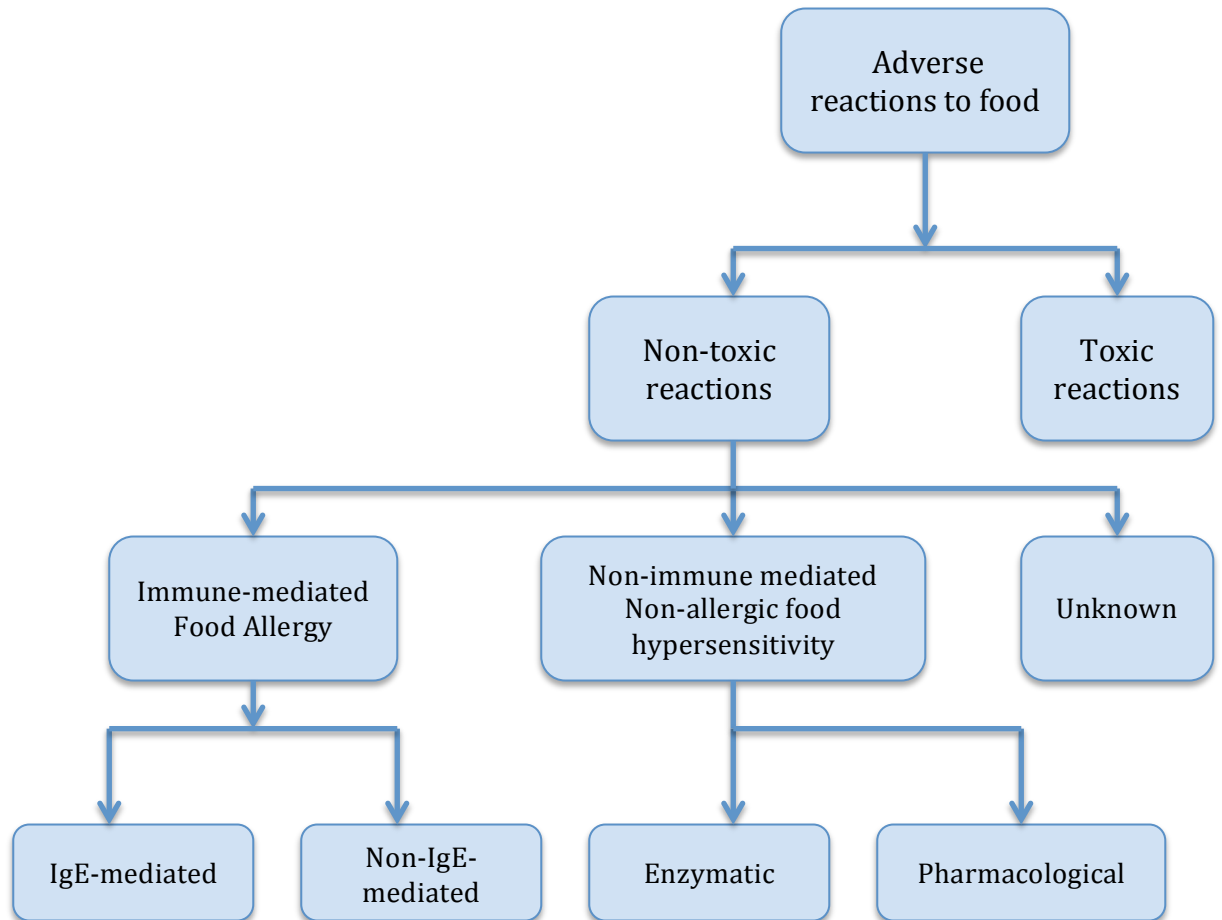
2.2. Symptoms associated with adverse food reactions

Symptoms that have been most commonly associated with adverse reactions to food include gastrointestinal, skin and respiratory symptoms, but also can include mood disturbances, inflammation and behaviour problems (Skypala, 2011; Johansson et al., 2001; Zuberbier, Worm, Reimann, Roehr, & Niggemann, 2004). These symptoms differ in the onset of their presentation,

and depending on whether the adverse food reaction is immune-mediated or non immune-mediated, they can present either within a very short, or a longer period of time (hours or days) of food consumption. Symptoms specifically associated with IgE-mediated food allergy include severe itching of the skin, urticarial rash or hives, reddening of skin, swelling, racing heart, abnormally low blood pressure, throat tightness, shortness or breath and less often, collapse (Skypala, 2011). The most severe reaction is anaphylaxis, a life-threatening reaction, which includes organ failure, low blood pressure, and shock (Johansson et al., 2001). IgE-mediated allergic food reactions typically present immediately, within a few minutes of eating (Ortolani, Ispano, Pastorello, Ansaloni, & Magri, 1989).

Both instant and delayed-onset reactions have been regarded as common manifestations of non-IgE-mediated food allergy, such as coeliac disease and eosinphilic esophagitis. Coeliac disease is a serious autoimmune condition triggered by gluten, a class of proteins, contained in wheat (Anand, Piris, & Truelove, 1978). The symptoms of coeliac disease include diarrhoea, abdominal distension, and weight loss. Eosinophilic oesophagitis (EoE) causes an inflamed oesophagus, the tube connecting the mouth to the stomach (Lucendo et al., 2004). Eosinophilic oesophagitis has been thought to be a reaction of food allergy, but may also be the result of other allergic conditions, such as hay fever to pollen or asthma (Lucendo et al., 2004).

Some non-allergic (non-immune mediated conditions), such as lactose intolerance have well recognised reactions. Non-immune mediated food sensitivity or intolerance usually presents with a delayed reaction, sometimes hours or days after consumption of certain foods (Skypala, 2011). Pharmacological reactions, natural substances in the food and enzyme deficiencies have been considered as the possible causes of these reactions (Johansson et al., 2004; Wuthrich, 1993; Zuberbier et al., 2002).

From all types of symptoms, gastrointestinal symptoms have been regarded as the most commonly reported adverse reactions to food and have been associated with both immune-mediated and non-immune mediated conditions (Zuberbier et al., 2004).

2.3. Diagnosis of food allergy and food intolerance

The diagnosis of food intolerance or food allergy can be a complicated process, as adverse food reactions can present in many forms, and symptoms of both immune-mediated and non-immune-mediated reactions could overlap. The number of different types of practitioners that can be involved, ranging from GPs, gastroenterologists, immunologists, allergy specialists, to complementary and alternative practitioners and dieticians, who provide advice and testing according to their speciality can also make the process of diagnosis of food allergy and intolerance difficult. This process can be further complicated by the range of commercial tests available on the market, including tests for self-diagnosis.

Before undertaking formal diagnosis of food allergy, it is a common practice to obtain first clinical history and conduct physical examination of the patient (Dimov, 2008; Skypala & Venter 2009). Clinical background, together with skin prick testing (SPT) and Immunoglobulin E (IgE) level testing has been found to only provide indication for the likelihood of a reaction (Dimov, 2008; Skypala & Venter 2009). The recognised standard for objectively diagnosing food allergy is the oral food challenge and specifically, the double-blind placebo-controlled food challenge (DBPCFC) (Boyce et al., 2010; Bindslev-Jensen et al., 2004).

Figure 2 shows the range of diagnostic tests, including complementary and alternative medicine used for food allergy/intolerances. Each of these will be described briefly in the subsequent section.

Figure 2. Categories of tests used for diagnosis of allergies/intolerances
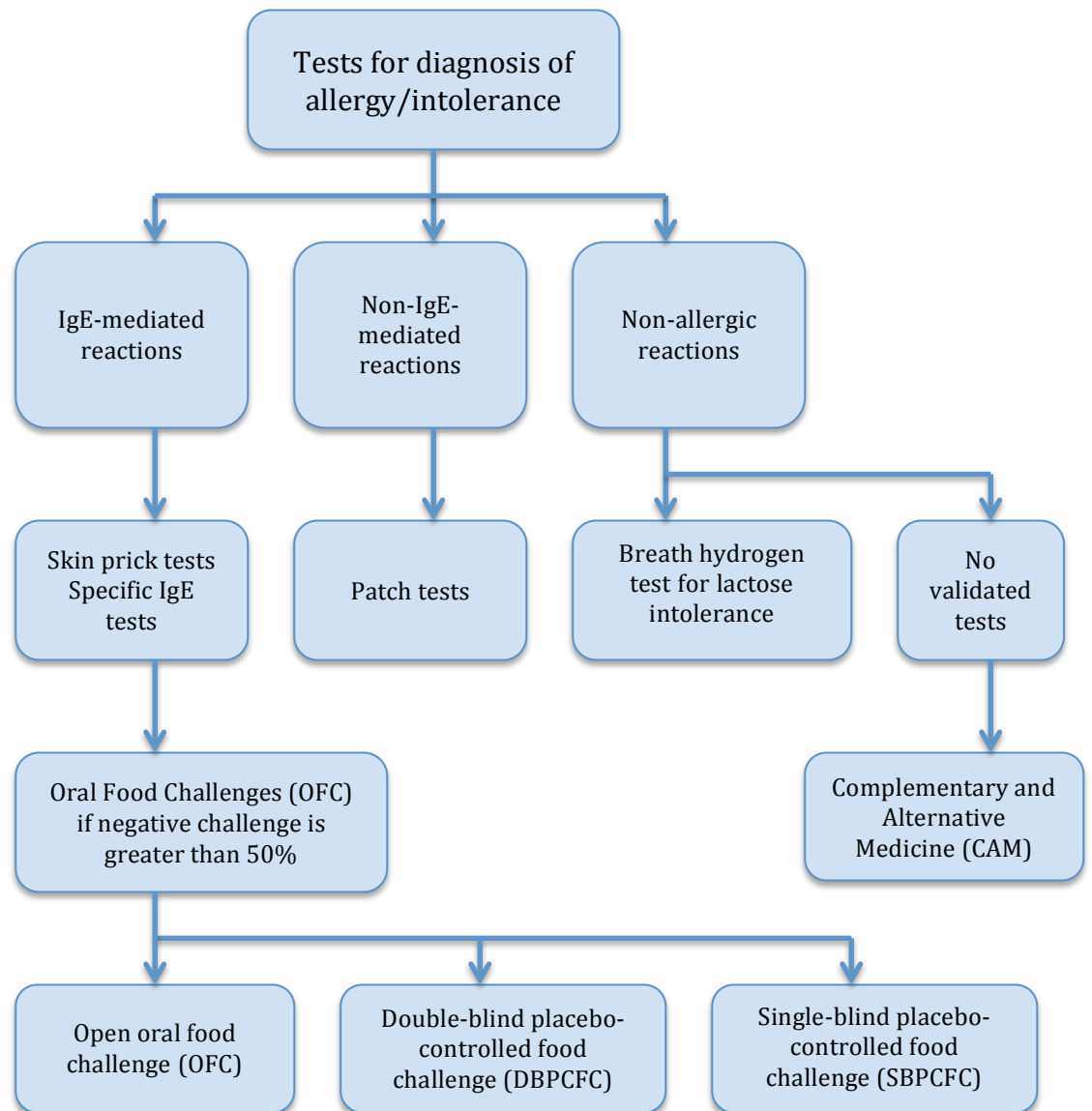
2.4.   Tests used for diagnosis of allergies/intolerances

2.4.1. Skin prick tests (SPT)

Skin prick tests are commonly used to test for an immediate IgE-mediated allergic reaction and as such are regarded as one of the main diagnostic tools for detection of allergy (Bousquet et al., 2008; Demoly, Bousquet & Romano, 2009;

Cox et al., 2008). Skin prick tests (SPT) measure specific IgE attached to mast cells in the skin (Skypala & Venter, 2009). However, these tests are not regarded as a perfect indicator of food allergy, considering that a positive IgE in the skin or in the blood only shows that a person is sensitised to an allergen. SPT results should be viewed in the context of the individual's medical history, symptoms, and other specific antibody IgE measurements. Skin prick tests are conducted by placing glycerinated food extracts on the skin and pricked with a needle. The test is difficult to interpret and the test materials have to be handled with care to exclude negative SPT results, due to potential dermatographism in the test subject, or the presence of other medications (Skypala & Venter, 2009). Two controls are used - a positive (histamine) and a negative (saline). The size of the wheal resulting from the food allergen is interpreted relative to the size of the negative control. The largest wheal diameter of each test is evaluated and the test is interpreted as positive when the wheal is greater or equal to 3 mm (Konstantinou, Bousquet, Zuberbier & Papadopoulos, 2010). The skin prick tests do not indicate the severity of the reaction. A positive SPT is considered to mean with 50% positive accuracy that the person may have a true IgE-mediated allergy to the food. Negative SPTs are considered more accurate (95% predictive value) in ruling out an IgE-mediated allergy (Konstantinou et al., 2010).

2.4.2. Total IgE tests

This test measures all IgE in the blood and it is not considered to be a helpful test, due to number of conditions, such as eczema, that could cause a high IgE levels, without any relevance to food allergy (Skypala & Venter, 2009).

2.4.3. Specific IgE allergy blood test

The specific IgE allergy blood test (previously by the name of RAST) assesses the amount of IgE to a specific allergen that causes a reaction (Skypala & Venter, 2009). This blood test has some advantages over skin prick testing ranging from the ability to be reproduced, to being extremely sensitive, and to being highly specific, as it binds to allergen specific IgE. The specific IgE allergy blood test works by binding the offending allergen to an insoluble material and then adding the patient's serum. If antibodies to the allergen are contained in the serum they will bind to the allergen. The IgE antibodies that do not bind to the allergen are washed away. This test could give an elevated result without the patient having any symptoms (sensitisation) (Skypala, 2011), and the elevated IgE is harmless. When an elevated IgE is observed in combination with symptoms to the allergen, the term "allergy" applies. Therefore, specific IgE testing is commonly requested for an allergen against which a patient has complained of symptoms.

2.4.4. Component resolved IgE testing

This recent type of IgE testing, also known as component resolved diagnosis (CRD), has been used by laboratories to detect IgE levels corresponding to specific parts of an allergen. Research has demonstrated that for some food allergens, such as peanuts, a positive CRD to a particular part of the peanut protein may indicate a more severe allergy than to other parts (Aalberse et al., 2013).

2.4.5. Patch Tests

A patch test is a method to test if a specific substance causes an allergic reaction on the patient's skin, and is often used for individuals suspected of having an allergic contact dermatitis, atopic dermatitis or allergic eczema. For the patch test procedure, food allergens are applied to a healthy area of the skin, the reactions range from negative to extreme and the effects are evaluated 48-72 hours later (Zug et al., 2009).

2.4.6. Oral Food Challenge (OFC)

Food challenge is a test where increasing amounts of suspected allergen food are consumed at fixed intervals, usually at 10-30 minutes, under observation until there is a reaction or a normal amount of food is consumed without symptoms (Dimov, 2008). Oral food challenge is the accepted standard for objectively diagnosing food allergy (Boyce et al., 2010; Bindslev-Jensen et al., 2004), for those who have a history of adverse food reactions. Suspected food allergic reactions may be confirmed or rejected by food challenge tests and are important for a reliable diagnosis and subsequent diet recommendations (Boyce et al., 2010). It is used to reconfirm allergic reactions which may be outgrown as well as to establish threshold values for the individual patients and the severity of reactions (Crevel, Briggs, Hefle, Knulst, & Taylor, 2007).

2.4.7. Open food challenges (OFC)

The procedure of the open food challenge requires that both the patient and the clinician performing the procedure are aware of the food, used for the challenge, for example peanut flapjack for a peanut challenge (Skypala & Venter, 2009). Open-food challenge, despite being a preferred method for testing due to its practicality, has been reported to produce 27% more positive challenges than the double-blind, placebo-controlled food challenge (DBPCFC) (Skypala & Venter, 2009; Venter et al., 2007).

Single-blind placebo-controlled food challenges (SBPCFC)

For this type of food challenge, the physician is aware of what is being given to the patient, but the patient cannot distinguish between the active and the placebo dose. Masking of the food is required, for example, a person with suspected nut allergy is given crushed nuts mixed with other food (Skypala & Venter, 2009).

Double-blind placebo-controlled food challenges (DBPCFC)

The double-blind placebo-controlled food challenge (DBPCFC) has been recommended by US and European guidelines as the gold standard for food allergy diagnosis (Boyce et al., 2010; Johansson et al., 2004; Chapman et al., 2006; Bindslev-Jensen et al., 2004). For this diagnostic test, the challenge food is disguised and neither the physician nor the patient are aware of which dose is active, and which is the placebo. The test result is considered positive, when the patient experiences symptoms during the food challenge in accord with the symptomatic history, or when allergy-type symptoms are experienced during the challenge, that are authenticated by the physician (Skypala & Venter, 2009).

Guidelines for performing OFC

Patients should not go through OFC if they have a history of severe reactions, if they are not well on the day of the challenge, or if they are taking medication, which could alter the challenge test result. Both European and US guidelines (Boyce et al., 2010; Bindslev-Jensen et al., 2004) recommend that OFC be used where immediate IgE allergy is suspected and where objective symptoms that can be measured independently (Skypala, 2011). It has also been recommended as preferable that an initial positive OFC be accompanied by a demonstration of immune (IgE) involvement to label the reaction a food allergy (Boyce et al., 2010; Bindslev-Jensen et al., 2004). Where the results of the OFC are negative, it is assumed that there is no need for DBPCFC (Boyce et al., 2010; Rusznac & Davis, 1998; Roberts, 2005).

However, if the results of OFC are positive, performing a DBPCFC has been considered as a next step, for being more robust. It has been recommended that challenges should be continued until objective and/or severe, reproducible, persistent symptoms are observed (Niggemann, 2010).

2.4.8. Hydrogen Breath Test

The hydrogen breath test measures levels of hydrogen in the breath and is used to recognise several possible conditions that cause gastrointestinal symptoms (Simren, 2006). This test may be used for detecting small intestinal bacterial overgrowth and carbohydrate malabsorption that could produce symptoms in, for instance, irritable bowel syndrome. Hydrogen breath testing is also performed for the diagnosis of lactose intolerance, a disorder in which dietary sugars are not digested in a normal way (Bratten, Spanier, & Jones, 2008). The use of these tests is extensive and they may be administered at hospitals, clinics, GP practices, all places where the physician or laboratory has the proper equipment and breath collection kit. However, some controversial and divergent results and conclusions are drawn from studies regarding the usefulness of this measure, due to the suggestion that testing may not correlate with any actual diagnosis (Bratten et al., 2008).

2.4.9. Complementary and alternative medicine (CAM)

Lately, commercial enterprises have introduced self-administered tests that are marketed as able to "diagnose" food intolerance by measuring the presence of another type of antibody, IgG, in a small quantity of blood. It has been argued that this has confused and extended the definition of food intolerance by claiming an immunological origin of the symptoms (Teuber & Porch-Curren, 2003; Nettleton, Woods, Burrows & Kerr, 2010). The claims that raised levels of IgG are responsible for intolerance symptoms have been dismissed within conventional medical circles. It has been argued that raised levels of IgG are not indicators of any pathology, but are a normal immune

response to common foods, and that they do not produce symptoms of classic food allergy (Morgan, Daul & Lehrer, 1990; Szabo & Eigenmann, 2000).

Complementary and alternative medicine practices have been known to use techniques, such as homeopathy, naturopathy, ancient healing systems (based on Chinese and Indian traditional medicine), biologically based practices, mind-body techniques and others. A review of the literature by Teuber and Porch-Curren (2003) on the most common alternative and complementary medicine tests has concluded that there is no evidence to support the diagnostic validity of food-specific IgG in any particular disorder. This conclusion has been supported by other studies (Wuthrich, Schmid, Walther, & Sieber, 2005).

Many available complementary and alternative diagnostic techniques in the area of food intolerances are considered as not based on experimental proof of concept (Teuber & Porch-Curren, 2003; Niggerman & Gruber, 2004). These diagnostic techniques include electrodermal tests, leukocytotoxic tests, kinesiology, provocation/neutralisation procedure, hair content analysis and iridology (Lewith et al., 2001; Terr, 1983; Skypala & Venter, 2009). In electrodermal tests the outcome depends on whether the skin electrical conductance changes when the individual comes into contact with an allergenic substance. Studies, randomised and double-blind, have not succeeded in demonstrating any correlation between results of this type of testing and actual sensitisations. In other words, the electrodermal test has not been able to identify the allergic subject and has displayed unacceptable variability (Lewith et al., 2001).

Leukocytotoxic tests are based on the theory that peripheral leukocytes modify shape or volume when they interact with allergenic substances (Terr, 1983). Available studies have showed unacceptable variability of this test

and no correlation with clinical parameters (Benson & Arkins, 1976; Lehman, 1980; Lieberman, Crawford, Bjelland, Connell, & Rice, 1975). There are no recently published studies on the usefulness of this diagnostic test and its validity has not been previously supported in research (Teuber & Porch-Curren, 2003; Bindslev-Jensen & Poulsen, 1996). The practice of kinesiology claims that when a subject comes into contact with an allergenic substance a reduction of the muscular strength of contraction occurs (Skypala & Venter, 2009). A few studies (Garrow, 1998; Ludtke, Kunz, Seeber & Ring, 2001) have not succeeded in demonstrating the diagnostic validity and reliability of this test and have concluded that kinesiology, as a diagnostic tool is not more useful than random guessing (Teuber & Porch-Curren, 2003).

Provocation/neutralisation procedure involves either injecting under the skin or placing under the tongue a small amount of test substance, for example milk or egg (Fox, Sabo, Williams, & Joffres, 1999). If this test produces symptoms, a larger dose is given which should neutralize the adverse effect of the first dose. Studies on the basis of double-blind procedures have found that test substance produced reactions in only 16% and placebo in 24% of people, without correlation with clinical history (Jewett, Fein, & Greenberg, 1990) and have concluded that "the results of provocation-neutralization testing, using symptoms alone as an indicator of neutralization, should not be used as a basis for clinical intervention" (Fox et al., 1999). Other tests, such as analysis of hair content and iridology have also been used to diagnose food intolerance and allergy. Studies have demonstrated the results of hair tests as being completely random with variability approximating 100% (Sethi et al., 1987), and iridology as being unreliable and not scientifically supported (Ernst, 2000).

2.5 Prevalence and use of Complementary and Alternative Medicine (CAM)

Despite the inconclusive and unreliable character of the complementary and alternative medicine diagnostic and treatment techniques, research data show that their use for food allergies and sensitivities has been increasing (Kessler et al., 2001; Moquin, Blackman, Mitty, & Flores, 2009). Several studies have reported the prevalence and usage of CAMs around the world. They have indicated that in Australia and in the USA, the percentage of the general population who used CAMs, reached up to 50% (McLennan, Wilson, & Taylor, 1996; Ernst, 2000; Blanc et.al, 2001), and was as high as 70% in Germany and France (Fisher & Ward, 1994). Data from a study on the USA civilian population has showed that 62% of adults used some form of CAM during that year, including prayer for health reasons (Barnes, Powell-Griner, McFann, & Nahin, 2004). A study of the popularity, costs and reasons for use of unconventional medicine in an American national sample, (Eisenberg et al., 1993) found that of 1539 adult respondents, 34% used at least one alternative therapy in the past year, and a third of these visited complementary and alternative medicine providers. The majority of people in the study used unconventional medicine for chronic and less-serious medical conditions, and the highest use was reported by white, relatively young persons, with higher education and incomes. Extrapolation by the study of these results to the US population has demonstrated that CAMs visits (425 million) and expenditures ($13.7 billion) have exceeded the number of visits (388 million) and expenditure ($12.8 billion) to all primary care US physicians (Eisenberg et al., 1993).

Other studies have reported figures, with regard to use of CAM of patients with food allergy/sensitivity, of approximately 27% for Germany (Schäfer, Riehle, Wichmann, & Ring, 2002), and approximately 30% for Italy (Senna et

al., 1999; Senna et al., 2000). Between 11% and 43% of patients with other gastrointestinal disorders (Smart, Mayberry & Atkinson, 1986) have also been reported to use complementary and alternative medicine. Australian population studies (MacLennan et al., 1996; MacLennan, Wilson & Taylor, 2002) have reported that overall between 48.5% and 52.1% of the population used at least one non-medically prescribed alternative medicine, many of which were self-prescribed. Users were reported as mostly female, well educated and on higher incomes, and among users, 57.2% did not inform their medical doctor (MacLennan et al., 1996). A follow-up study indicated that 23% of the respondents had visited at least one alternative practitioner (MacLennan et al., 2002).

Various explanations for growth in usage of CAM have been considered, including marketing, availability of internet information, desire by patients for self-diagnosis, to be in control of their health and of medical decision making as well as possible dissatisfaction with conventional medicine (Barnes et al., 2004). Research has also shown that most people use complementary and alternative medicine as a complement to conventional medicine, and not as alternative (Astin, 1998; Druss & Rosenheck, 1999; Eisenberg et al., 1998).

3. Implications of heterogeneity of diagnostic tools

There are several implications of the variety and large number of diagnostic tools described in the above sections, which are used for diagnosing food intolerance. These different diagnostic tools add to the complexity of the diagnostic process and are believed to contribute to a marked heterogeneity between studies regarding the prevalence of the condition (Rona et al., 2007). The use of various diagnostic tools in research studies, ranging from short questionnaires, two-stage screening questionnaires and interviews through to IgE and SPT techniques (which may not be standardized between

manufacturers), and DBPCFC's, explains the diversity of study designs to assess the prevalence of food intolerance (Rona et al., 2007). Therefore, conclusions are to be drawn with caution from these reports regarding the consistency of information.

4. **Review of the literature on food allergy and food intolerance**

    4.1. **Studies on the prevalence of food allergy and food intolerance in adults**

Previous research has suggested that in Western countries, there is a significant discrepancy between self-reported (perceived) and medically diagnosed food allergies and intolerances (Rona et al., 2007; Berstad et al., 2005; Johansson et al., 2001).

A meta-analysis conducted by Rona et al. (2007) on the topic of food allergy or intolerance, which included 51 original articles published from 1990 to 2007, found that the prevalence of self-reported food allergy was very high compared to food allergy, confirmed by objective measures. The meta-analysis showed that many prevalence studies are based on reports of perceived food intolerance, and not on medically diagnosed intolerance detected by blood tests or DBPCFC. In the study of Rona et al. (2007), the self-reported prevalence figures of food allergy were estimated to reach up to 35% for any food, compared to the prevalence of IgE sensitization, or medically confirmed food allergy, which varied between 0.1% and 6% (Rona et al., 2007; Berstad et al., 2005; Johansson et al., 2001).

Accurate estimates of the prevalence of food allergy are difficult due to the lack of consistency in the type of assessment. Relatively few studies base their reported prevalence rates on double-blind placebo-controlled food challenges (DBPCFC), the gold standard of diagnosis (Eggesbø, Magnus,

Botten, Halvorsen, & Eggesbø, 2001; Niestijl Jansen et al., 1994; Osterballe, Hansen, Mortz, Høst, & Bindslev-Jensen, 2005; Young, Stoneham, Petruckevitch, Barton, & Rona, 1994; Zuberbier et al., 2004). More often, prevalence figures are calculated based on self-reported adverse food reactions (Altman & Chiaramonte, 1996; Emmett, Angus, Fry, & Lee, 1999; Marklund et al., 2004; Kanny, Flabbee, Morisset, & Thevenin, 2001; Lunet, Falcao, Sousa, Bay, & Barros, 2005).

The disparity in rates of perceived food intolerance versus actual allergy seems to be an international phenomenon. Research studies that have investigated the prevalence of food hypersensitivity in samples taken from America, the Netherlands, the United Kingdom, France, Germany, and other European countries have all indicated that genuine immunologically-based food allergy is rather uncommon, compared to high rates of perceived food intolerance (Altman & Chiaramonte, 1997; Niestijl Jansen et al. 1994; Kanny et al., 2001; Young et al., 1994; Zuberbier et al., 2004). The rates of perceived food intolerance are sufficiently high to have significant implications for the development of nutritional imbalances through food avoidance behaviour (Teufel et al., 2007; Monsbakken et al., 2005). A common finding from these studies has been the significantly higher prevalence of perceived food allergy or intolerance in women than in men (Kanny, et al., 2001;Young et al., 1994; Zuberbier et al., 2004; Altman & Chiaramonte, 1997).

4.2. Studies on psychological characteristics of people with food intolerance

Although the prevalence rates of food allergies and intolerances and the discrepancy between medically confirmed and perceived food intolerances in Western populations have been well documented, the mechanisms underpinning this difference are unclear. With the exception of the study of

Peveler et al. (1996), the studies that have investigated and observed psychological and other characteristics of people with perceived food intolerance, have included small samples of participants (Pearson et al., 1983; Vatn et al., 1995; Parker, Garner, Leznoff, & Sussman, 1995; Lind et al., 2005), and have been either limited to patients from allergy clinics (Rix et al., 1984; Pearson et al., 1983; Lillestøl et al., 2010), or to young college populations (Bell et al., 1993).

A review of the literature on adverse food reactions, conducted by Teufel et al., (2007) revealed the difficulty in distinguishing between the different forms of adverse food reactions, as reasons for why symptoms are often attributed to food allergy, food intolerance, irritable bowel syndrome and other somatoform disorders. The review also referred to the possible involvement of psychological effects, which are thought of as either contributing or determining the symptomology. Together these issues have led to challenges in the characterizing of the epidemiology of adverse food reactions. The high prevalence of perceived (i.e., non-medically diagnosed) food intolerance indicated in the literature (Rona et al., 2007; Teufel et al., 2007), has raised questions regarding the psychogenic and non-psychogenic factors that may predispose certain individuals to attribute distressing symptoms to the consumption of certain food items or components and, without supporting evidence from expert diagnosticians, to subsequently label themselves as food intolerant.

Approximately thirty years ago, a study by Pearson et al. (1983) posed the question "Food allergy: how much in the mind?" At that time, the results of the study with patients, recruited from an allergy clinic, indicated a high prevalence of psychiatric disorders (anxiety and depression) and high suggestibility in the individuals whose food allergy could not be medically confirmed. The study of Pearson et al. (1983) was unable to obtain objective evidence that symptoms other than those usually associated with classic

allergy were the result of food intolerance. The patients with confirmed allergy had no psychogenic symptoms associated with their food consumption, unlike patients with no objective evidence of food allergy, who had revealed some form of psychiatric disturbance and who attributed many of their physical and mental symptoms to foods they consumed. The results of the study also showed that several patients were able to eat previously avoided foods after they changed their stress-experience levels, were treated for depression, or had some therapy. These findings were thought to indicate that, in at least some patients, psychological factors were the cause rather than the result of food intolerance (Pearson et al., 1983).

Other research has also directed attention to psychogenic characteristics observed in patients with perceived food intolerance: in particular, neuroticism, anxiety, negative affect and heightened vigilance for sensations or symptoms (Lied et al., 2011; Lillestøl et al., 2010; Berstad et al., 2005; Bell et al., 1993; Rix et al., 1984; Knibb et al., 1999; Lind et al., 2010). One of these traits, neuroticism, is formally defined as emotional instability with overwhelmingly negative emotions, such as mood volatility, worry, anger, sadness, anxiety, hostility, self-consciousness, and vulnerability, all of which have been found to highly correlate with one another (Costa & McCrae, 1992a; Goldberg, 1993). Neuroticism has been implicated in an extensive range of both mental and physical health problems (Ellenbogen, Ostiguy, Hodgins, & Norman, 2010; Lahey & Anderson, 2009). Other than perceived food intolerance, neuroticism has also been associated with gastrointestinal disorders, such as irritable bowel syndrome (Spiller, 2007; Farnam, Somi, Sarami, Farhang, & Sanaz, 2007; Tayama et al., 2012) as well as with asthma (Huovinen, Kaprio, & Koskenvuo, 2001). Research studies have also found significant associations between neuroticism and depression, generalized anxiety disorder, and panic disorder (Khan, Jacobson, Gardner, Prescott, & Kendler, 2005). Of particular relevance is the finding that individuals with high scores on neuroticism have been found to be more likely to complain of

medically unexplained somatic reactions, (Chaturvedi, 1986; Costa& McCrae, 1987) and to have catastrophic thoughts about symptoms. All of these can result in overuse and burdening of the medical system (Goubert, Grombez & Van Damme, 2004).

A community study that randomly recruited 955 adult participants from the midlands of England, of whom 232 reported perceived food intolerance, found different prevalence levels of psychological distress between people with and without perceived food intolerance (Knibb et al., 1999). The findings indicated that perceived food intolerance was associated with higher scores on neuroticism, compared to the rest of the sample. Women with perceived food intolerance had significantly higher scores than control women on somatic symptoms (symptoms that cannot be explained by a general medical condition), anxiety, insomnia, and severe depression. Neuroticism scores were also higher in men with perceived food intolerance than in control men. The authors in the study proposed that neuroticism might be a trait associated with perceived food intolerance in both genders, however somatic symptoms, anxiety, and depression may be associated with perceived food intolerance only in women (Knibb et al., 1999).

The studies of Rix et al. (1984) and Bell et al. (1993) have also investigated psychogenic characteristics of patients with perceived food intolerance. Rix et al. (1984) examined 23 patients who believed they suffered from food allergy when they presented to an allergy clinic. The study found that genuine food allergy could not be confirmed in 19 of the patients. These patients attributed common neurotic symptoms to food allergy and in terms of psychiatric symptomatology and characteristics, as a group, were found to be almost identical to a group of new psychiatric outpatients. The study results revealed no evidence of psychiatric disorder of food-related psychological symptoms in the four patients with medically confirmed food

allergy. It was concluded that genuine, allergic reactions to foods were not associated with psychological symptoms.

The study of Bell et al. (1993) investigated self-reported intolerance to several common foods and chemicals, symptom patterns, and psychological characteristics in a sample of 490 young adult college students. The results showed a correlation between food intolerance and depression, anxiety, and somatisation (tendency to experience and communicate psychological distress in the form of somatic symptoms). Food intolerance was also associated with high total symptoms scores, as well as more indigestion, headaches and memory problems, even after controlling for depression, anxiety, shyness, defensiveness, and gender (Bell et al., 1993).

More recent literature, and the result of ten years of interdisciplinary research into food intolerance in clinical populations, has suggested that perceived food intolerance is a sensitisation disorder, not necessarily due to immunological mechanisms (Lied et al., 2011; Berstad et al., 2005; Lind et al., 2005; Arslan et al., 2004; Arslan, Lind, Olafsson, Florvaag, & Berstad, 2004; Eriksen & Ursin, 2004; Lind et al., 2010). This research included in total more than 400 patients who were all referred to the research clinic due to gastrointestinal complaints self-attributed to food intolerance. The process of diagnosing the patients with food intolerance included medical history taking, examining IgE levels in skin prick tests, open food provocation tests and double-blind placebo-controlled food challenges (DBPCFC), gastrointestinal examination, which ruled out organic diseases, and diagnosis of IBS on the basis of the ROME II criteria (Arslan et al. 2004). The investigations almost exclusively focussed on the possible contribution of psychogenic factors, such as anxiety, negative affect, and somatosensory amplification, to the pathogenesis of the patients' condition (Lillestøl et al., 2010; Berstad et al., 2005). More than half of the patients with perceived food intolerance were assessed as fulfilling the DSM-IV criteria of a psychiatric disorder, with depression (in 16% of patients), generalised

anxiety disorder (15%), panic disorder (13%) and somatoform disorders (12%) observed.

According to the findings from this body of work the most frequent symptoms reported by patients with food hypersensitivity were fatigue (93%), bloating (87%), headache (85%), diarrhoea (83%), and low back pain (70%). The most prominent psychological characteristics were anxiety and depression, as well as complaints of feeling "sick all over" (Lied et al., 2011). Compared to healthy controls, most of the patients with perceived food intolerance scored abnormally high on subjective health complaints: perception of symptoms in the absence of identified organic abnormalities that can explain the symptoms (Lind et al., 2005). Patients with perceived food intolerance demonstrated strong assumptions and attributions regarding the causes of their symptoms and consistently reported concern with specific foods, rather than concern about their overall health or influence of environmental factors on their health.

Despite the fact that food allergy was rarely found in these patients, they were characterised as being continuously scanning the environment for health dangers, extra-vigilant with respect to their symptoms, constantly worried about their condition, and trying everything possible to avoid foods to which they attributed their problem (Berstad et al., 2005). The researchers explained this phenomenon in terms of the possible contribution of cognitive-emotional sensitization at the brain level (Berstad et al., 2005), a form of cognitive bias leading to over-reporting of somatic sensations and misattribution of bodily symptoms (Arslan et al., 2004; Brosschot, 2002). This kind of cognitive bias in interpreting symptoms that reach consciousness has been considered in one of the most influential models by Barsky & Wyshak (1990) – the somatosensory amplification tendency.

The somatosensory amplification tendency has been described as the tendency to experience somatic sensations as intense, noxious, and disturbing and has been associated with the reporting of somatic symptoms (Barsky, Wyshak, & Klerman 1990; Rief & Broadbent, 2007). The process has been described as a vicious cycle of enhancing somatic feelings and sensations, where the attribution of the sensations to a serious medical condition further leads to focusing of attention on bodily processes (Barsky et al., 1990). As a result of the focusing of attention, sensations are experienced as more disturbing and the perception of physical signals is amplified. The patients develop a valid and self-perpetuating cycle of symptom amplification, confirmatory bias and reinforcement of illness belief (Barsky & Borus, 1999). This cognitive appraisal has been proposed to have a strong link to hypochondriacal beliefs, or health anxiety (as currently referred to in the DSM-V) (Barsky et al., 1990). To date research has yielded mixed results on whether the effect of the amplification tendency is independent or whether it is mediated by anxiety, depression or neuroticism (Duddu, Isaac, & Chaturvedi, 2006; Barsky, Goodson, Lane, & Cleary, 1988; Muramatsu et al., 2002; Barsky et al., 1990; Wise & Mann, 1994; Aronson, Barrett, & Quigley, 2001). The study of Aronson et al. (2001) reported a weak discriminant validity of the somatosensory amplification tendency, as it was found to correlate with self-report measures of negative emotionality, depression, anxiety, and with negative mood. This was interpreted as an indication that the somatosensory amplification measure and measures of psychological disorder and negative emotionality were likely representing similar constructs (Aronson et al., 2001).

The association between perceived food intolerance and psychological distress, as suggested by the research studies discussed above, was not supported by a community study of food intolerance (Peveler et al., 1996). Rather, the findings of Peveler et al. (1996) revealed that most individuals, who reported symptoms associated with food consumption, and who were

found not to be allergic on medical grounds, did not show significant mood disturbance, impaired social adjustment, or other psychological symptoms. The study found that the subjects differed according to their principal causal attribution for symptoms, with patients who attributed their symptoms to food intolerance reporting a lesser degree of mood disturbance and impact of symptoms on everyday life than those attributing symptoms to other gastrointestinal problems or stress. They were also less likely to consult general practitioners and other medical specialists, compared to others in the general population.

4.3. Limitations in existing studies of perceived food intolerance

Several key limitations are identified with previous studies (both clinical and population) in the literature of perceived food intolerance. First, the cross-sectional nature of these studies makes it difficult to make any claims for cause and effect regarding symptoms experienced and psychological characteristics of individuals. Cross-sectional studies being a research tool used to capture information based on data gathered for a specific point in time therefore cannot be used to analyse behaviour over a period of time and the timing of the snapshot is not guaranteed to be representative.

Secondly, both clinical and population studies in the literature of perceived food intolerance each have their own limitations and their findings should be interpreted with caution. Clinical studies, often due to their small size have the benefit of being able to test their participants for genuine food allergy or intolerance, using blood tests or DBPCFC. However they may also recruit a sample of participants with more severe symptoms, psychiatric illness, or from a particular socio-economic group. Population studies, although able to collect large data from respondents, being relatively easy to administer and

cost effective, are prone to several response biases (as they rely on self-report only) and are not able to test their participants for genuine food allergies or intolerances. It should also be acknowledged that although in population studies a percentage of people reporting a self-diagnosis of food allergy or intolerance may have misdiagnosed their symptoms, it is also possible that some may have decided not to visit a health care practitioner, but they may indeed have a genuine allergy or intolerance. Therefore, it cannot be always assumed that all individuals who self-diagnose are potentially incorrect in their diagnosis. Some studies have found, for example, that people make plausible diagnosis when they can recall adverse symptoms following certain food consumption, the speed, which the symptoms have manifested after the consumption and the number of times, these episodes have repeated (Knibb et al., 1999; Knibb & Booth, 2011)

Thirdly, these studies predominantly investigated the phenomenon of perceived food intolerance in small clinical populations, specifically samples of patients from allergy clinics (Lied et al., 2011; Lillestøl et al., 2010; Rix et al., 1984; Pearson et al., 1983). Secondly, their key findings have not generalised to the few community or general population samples in which this issue has been investigated (Knibb, et al., 1999; Peveler, Mayou, Young, & Stoneham, 1996; Monsbakken, Vandvik, & Farup, 2005). Thirdly, the research focused predominantly on the role of psychogenic factors, such as anxiety, negative affect, and cognitive bias in the possible misperception and misattribution of symptoms (Berstad et al., 2005). This theoretical perspective is in accord with existing models of unexplained symptoms (Barsky, Wyshak, & Klerman, 1990; Ursin, 1997; Kirmayer & Taillefer, 1997). In general, these models share an overestimation of the relationship between physical symptoms and perceived illness and place importance on the contribution of anxiety, negative affect and somatosensory amplification to the formation, perception, and attribution of symptoms and illness beliefs (Rief & Broadbent, 2007).

Several models of psychological mechanisms have been linked to the development and maintenance of medically unexplained symptoms (MUS) (Barsky et al., 1990; Ursin, 1997; Kirmayer & Taillefer, 1997). One of these models, based on Ursin's (1997) theory of cognitive sensitization for medically unexplained complaints, has been described as a possible mechanism for the development, maintaining, and reporting of symptoms of perceived food intolerance (Berstad et al., 2005). Sensitization has been described as a mechanism, which helps an individual to react more efficiently when faced with increased probability of potential threat by amplifying it (Brosschot, 2002). According to sensitization theory patients with subjective complaints tend to have an excessive sensitivity to signals sent from various parts of the body, including the gastrointestinal tract (Ursin, 1997). The theory of cognitive sensitization for medically unexplained complaints, especially for somatic symptoms and hypochondriasis, has been regarded as close to that for anxiety: those who have an extreme anxiety about somatic disease will develop a cognitive bias for information related to that somatic disease (Brosschot, 2002). As a result, such individuals tend to become more aware of illness-related bodily internal and external cues, interpret ordinary internal and external information in terms of illness, misattribute harmless signals to illness, and produce more and stronger memory traces for illness - related information (Brosschot, 2002).

In their study, Berstad et al. (2005) drew on that theory and suggested that food hypersensitivity is also a sensitisation disorder, not due to immunological mechanisms but rather at brain level, a cognitive-emotional sensitisation. They proposed that the majority of patients with non-medically diagnosed food intolerance spend a lot of time on scanning the environment for dangers. The patients in the study were described as worrying about their condition and associating their symptoms with a

certain food with strength of certainty that suggests the involvement of some cognitive bias (Berstad et al., 2005).

An influential model of MUS that describes such type of cognitive bias is the model of somatosensory amplification (Barsky et al., 1990). This model is appealing for the simplicity of its formulation and validation of its fundamental mechanisms, such as attention, perception, and attribution. However, the model is predominantly anxiety-focussed and therefore it is thought to best fit for anxiety-related symptoms, such as cardiovascular complaints (Rief & Broadbent, 2007).

The model of somatosensory amplification has been extended to include social and forensic aspects by Kirmayer and colleagues (Kirmayer & Taillefer, 1997). In their cognitive-perceptual model, the interpretation of bodily sensations as an indication of illness leads to help seeking, which can in itself be a maintaining factor. The authors have proposed that negative doctor-patient interactions or unsatisfactory reassurance increase the distress associated with symptoms. An essential part of Kirmayer's model is the integration of social factors, which include other health care providers, work conditions, insurance, and compensation systems. These social factors are described as reducing motivation to use self-help strategies and cope with symptoms. Through adding behavioural and social aspects and also including emotional factors (distress, demoralization) to the somatosensory amplification process, Kirmayer's model extends the pure perception-amplification process described in Barsky's model. In Kirmayer's model, people can only develop MUS with the influence of others, reinforcing their illness behaviour, perception or attribution (Kirmayer & Taillefer, 1997; (Rief & Broadbent, 2007).

A limitation of both Barsky & Wyshak's model of somatosensory amplification and Kirmayer's model is that these models do not explain the

processes and interactions, but primarily describe them (Rief & Broadbent, 2007). Both models focus on and place importance on the role of cognitive factors. This aspect of cognitive models for patients with medically unexplained symptoms has been criticised (Rief & Broadbent, 2007), as needing modification: the explanations for physical sensations of patients with MUS are not simplistic and monocausal, but most likely include a broad variety of factors, including non-psychogenic factors.

4.4. Psychological characteristics of people avoiding wheat for the alleviation of physical symptoms in an Australian population study

A recent Australian population study investigated the phenomenon of the association of symptoms with the consumption of certain foods in the context of understanding the drivers of wheat avoidance (Golley et al., 2015). The study took a broadly based approach to investigating the characteristics of individuals who adhere to food avoidance behaviours for the alleviation of physical symptoms by assessing reported symptoms, diagnoses and information sources influencing the decision to avoid, as well as potential psychological predictors of this behaviour.

Psychological predictors

For the purposes of the study, three thousand surveys were distributed to a proportional stratified random sample of eligible voters selected from the eight States and Territories of Australia by the Australian Electoral Commission. One thousand one hundred and eighty four completed forms were returned (a response rate of 41.3%). The psychological measures used in the study included Neuroticism, measured by the NEO-N Domain (Goldberg et al., 2006). The study also included a measure of attitudes towards complementary and conventional treatments using two subscales

derived from a factor analysis of items designed for the purposes of the study (Golley et al., 2015). The 'Complementary treatments scale' (five items) and 'Conventional treatments scale' (four items) asked participants to rate how likely would they be for a serious health matter to consult doctors and other medical practitioners, to consult any complementary or alternative practitioners and to take prescription medication, supplements or vitamins or natural remedies.

The study also employed Epstein's Rational Emotive Index (Epstein, Pacini, Denes-Raj, & Heier, 1996), represented by the scales for 'Faith in Intuition' and 'Need for Cognition'. The Rational Emotive Index is a self-report measure of what have emerged as two fundamentally different models of processing information in human judgement and decision-making (Zajonc, 1980): one that has been referred to as intuitive, heuristic, affect heuristic, prototypical, experiential, or first-signal system (Chaiken & Manis, 1980; Fiske & Tailor, 1991; Slovic, Finucane, Peters, & Macgregor, 2007; Tversky & Kahneman, 1983; Rosch, 1983; Epstein, 1983; Epstein et al., 1996), and the other as thinking-conceptual-logical (Buck, 1985; Leventhal, 1984), analytical-rational (Epstein, 1983) or second-signal system (Orbeli,1964a; Pavlov, 1932). Measuring the relative degree to which people rely on the two processes has been regarded as useful in understanding receptiveness to different types of communication (Epstein et al., 1996). An example for this is the effective appeal to emotions, personal experience, and the use of concrete examples for individuals who process information mostly intuitively, whereas facts and logical arguments as being more effective for individuals who process information primarily in an analytical mode (Epstein et al., 1996; Cacioppo & Petty, 1982).

This theory of affect and decision making has been further developed by the work of Slovic et al. (2007) by demonstrating that people use an affect heuristic to make judgements. It has focused on the ways affect has been

manipulated in order to influence people's judgements, for example in applying "affective tags" to the packages of food products, such as "natural", "organic", "fat free", etc. (Slovic et al., 2007). These "affective tags" enhance meanings for consumers as well as the attractiveness of the products. Testing the usage of both intuitive and analytical information-processing styles is potentially important in understanding the decision processes leading to food avoidance behaviour, as it could also reveal the possible operation of simple heuristics by which people classify foods as fundamentally good or bad (Golley et al., 2015).

A fourth measure employed by Golley et al. (2015) assessed illness worry. Illness worry was measured with four items from the Whitely Index for the assessment of what is now referred to in the DSM-V as Illness Anxiety Disorder, formerly known as hypochondriasis (Pilowsky, 1967). Worry about illness may represent a form of health anxiety of which illness anxiety disorder (hypochondriasis) is an extreme state. While this disorder has often been described as originating from psychodynamic, interpersonal, and behavioural perspectives, it has also been thought of as a disorder of perception and cognition (Barsky & Klerman, 1983). The DSM-V description of Illness Anxiety Disorder emphasizes the excessive concern with one's health in the absence of objective, verifiable evidence of a health condition (Diagnostic and Statistical Manual of Mental Disorders, fifth edition). Previously, health anxiety or hypochondriasis has been associated with somatosensory amplification, as it has been found to involve a heightened sensitivity to benign bodily dysfunction and normal physiology (Barsky et al., 1990). The process of amplification of symptoms in hypochondriasis has been described in the study of Barsky, Wyshak and Klerman, (1990). Their model states that, hypochondriacs amplify normal physiological sensations, and because their symptoms are intense, they mistakenly conclude that they are abnormal and pathological. Believing now that they are unwell, these individuals will tend to scrutinize their body further for additional

symptoms. They selectively focus on somatic perceptions, which confirm their illness hypothesis and ignore sensory signals that do not confirm it (Barsky et al., 1990). As a result, they can incorrectly attribute benign symptoms, to the suspected illness. In addition, increasing anxiety itself generates autonomic symptoms, such as bloating, increased heart palpitations, hyperventilation or breathing problems, and these new symptoms cause further additional anxiety (Barsky et al., 1990).

Barsky, Wyshak & Klerman's (1990) model does not necessarily imply a causal relationship between amplification and hypochondriasis. Since the study is cross-sectional rather than longitudinal, it is not possible to determine the direction of causality. It has been thought as possible that hypochondriacal concerns make people amplify bodily sensations, as it is that an amplifying style leads to hypochondriasis (Barsky et al., 1990). It is also noteworthy that, although the somatosensory amplification and hypochondriasis as measured by the Whiteley Index seem to be closely related and to measure overlapping characteristics, they are not meant to represent the same theoretical construct. The Whiteley Index was intended to measure attitudes, concerns, beliefs, and fears about health and disease (Pilowsky, 1967), while the somatosensory amplification scale (SSAS) measures extra-vigilance to and amplification of normal bodily sensations (Barsky et al., 1990).

Key findings

Several key points emerged from the data of Golley et al. (2015). The study revealed that a significant proportion (approximately 7.0%, translating to more than 1 million) of the Australian non-coeliac adult population reported avoiding consumption of wheat products for the alleviation of physical symptoms. Amongst these, reported gastrointestinal symptoms were prevalent (79.3% bloating or wind, 55.2% stomach discomfort or cramps,

31.0% constipation, 20.7% diarrhoea) and the almost complete absence of symptoms that might indicate an allergenic response was remarkable. Wheat avoidance occurred predominantly in the absence of formal medical diagnosis (only 16.1% of the symptomatic wheat avoiders reported having a formal diagnosis that required them to avoid wheat) and was predicted by increased receptiveness to complementary medicine and lesser receptiveness to conventional medicine. It was also significantly associated with being female. Reports of past diagnoses, independent of the question of food avoidance, indicated that a significant number of wheat avoiders had been diagnosed at some point in time with food sensitivity or food allergy. Whether these diagnoses were indeed "formal" or medically supported was thought questionable, with the origins of wheat avoidance appearing to fall largely outside of the mainstream medicinal practice due to non-medical information sources being prominent among rated influences on the decision to avoid wheat.

An important finding of the study was the large number (52.9%) of self-identified symptomatic wheat avoiders, who also reported avoiding the consumption of dairy foods. In addition to the significant implications of this behaviour for the development of nutritional imbalances, it pointed to a possibly widespread phenomenon of poly-avoidances (Golley et al., 2015). It raised questions regarding the potentially discrete or intrinsically related nature of these avoidances and pointed to the need for a further investigation of the symptoms, characteristics, and predictors of both wheat and dairy avoidance. Contrary to previous findings with clinical populations, which have associated perceived food intolerance with psychogenic factors, such as anxiety or negative affect (Lied et al., 2011; Lillestøl et al., 2010; Rix et al., 1984; Pearson et al., 1983), the findings of Golley et al. (2015) indicated that the behaviour of symptomatic wheat avoidance was not predicted by neuroticism, illness worry, or a lesser propensity for less logical or more intuitive thought. These findings are important, as they reinforce the

view that food avoidance, as a health-related practice might not be necessarily behaviour characterised by atypical psychopathology.

The non-medically diagnosed connection between ingestion of wheat products and symptoms and the self-management of these symptoms are also central to this thesis. It prompts questions regarding the processes of association of symptoms by which individuals arrive at the belief that they have adverse responses to certain foods in the absence of formal medical diagnosis. This connection is also supported by other research findings in the literature on the widespread tendency of invoking allergies or intolerance on the basis of questionable diagnoses, including self-diagnosis (Stein, 2009; Biesiekierski et al., 2011; McGowan & Gibney, 1993; Young et al., 1994; Rona & Chinn, 1987), and their treatment through elimination diets (Biesiekierski et al., 2011; Sloan & Powers, 1986). More importantly, the findings of the study provide original evidence of a widespread tendency of people to exercise control over their health, through the elimination of foods deemed to be harmful on some ground, and as part of a more general trend towards self-diagnosis and self-management of symptoms.

5. **A novel perspective on food intolerance: Somatisation in food intolerance – or a function of the experiencing of very severe symptoms?**

As discussed in the previous sections, studies of mostly clinical samples have associated perceived food intolerance with psychogenic factors, in particular, neuroticism, anxiety and negative affect (Rief & Broadbent, 2007; Lied et al., 2011; Lillestøl et al., 2010; Berstad et al., 2005; Bell et al., 1993; Rix et al., 1984; Lind et al., 2010), which have been suggested to contribute to extra-vigilance to symptoms and to the maintenance of the condition (Barsky et al., 1990).

Extra-vigilance to symptoms, or visceral hypersensitivity has also often been found in irritable bowel syndrome (IBS) patients (Wood & Mertz, 2003; Kanazawa, Hongo, & Fukudo, 2011) and described as being equivalent to somatosensory amplification tendency (Porcelli, 2004). A review of the published literature on IBS by Lydiard (2001) has indicated that psychological disturbances are common in IBS patients, especially those who seek treatment, and 50% to 90% of those who do have psychiatric disorders, including panic disorder, generalized anxiety disorder, social phobia, posttraumatic stress disorder, and major depression. Persistent somatisation, high dissatisfaction with health, low pain threshold and somatic amplification, leading to symptoms, high in frequency and severity, have been frequently identified as characteristics of IBS patients (Surawy, Hackmann, Hawton, & Sharpe, 1995; Frissora & Koch, 2005; Porcelli, 2004). In addition, it has been noted in the literature that some of the symptoms of IBS, which range from most gastrointestinal symptoms to fatigue, poor concentration and memory, muscular pain and joint pain, breathlessness and dizziness (Surawy et al., 1995; Frissora & Koch, 2005) are shared with the symptoms of perceived food sensitivity and intolerance, both abdominal such as bloating, stomach discomfort or cramps, and extra-abdominal, such as headache, joint pain, palpitations, breathlessness, asthma, eczema and fatigue (Young et al., 1994). It is not surprising, therefore that high prevalence rates of food intolerance have been reported among subjects with IBS (up to 84%) (Bohn, Storsrud, Tornblom, Bengtsson, & Simren, 2013; Simren, Abrahamsson, Svedlund, & Bjornsson, 2001; Nanda, James, Smith, Dudley, & Jewel, 1989; Dainese, Galliani, Lazzari, Di Leo, & Naccarato, 1999).

Researchers have suggested that some functional somatic syndromes (unexplained, persisting symptoms for which no objective or observable abnormalities have been found) should be considered as different manifestations of the same biomedical or psychosocial processes, because of

overlap between their symptoms (Wessely, Nimnuan, & Sharpe, 1999). Wessely et al. (1999) have argued that the existence of specific functional somatic syndromes could be regarded as an artefact of medical specialisation and a common set of symptoms is described according to that speciality.

The reported overlap in symptoms between IBS and food intolerance, together with the high prevalence of perceived food intolerance among subjects with IBS, and severe symptoms, frequently identified in both perceived food intolerance and IBS have raised questions, which establish the background for a novel approach to investigating food intolerance. Such is the question of whether food intolerance may represent another manifestation of the same psychosomatic processes associated with functional somatic syndromes, such as IBS, in particular with respect to vigilance to symptoms (or somatosensory amplification tendency), illness perception and illness behaviour. This thesis will explore these processes as potential mechanisms behind severe reactions to symptoms often reported in food intolerance.

A way of approaching this possibility will be to investigate the characteristics associated with food intolerance in the context of those associated with IBS. This will include paying special attention to the overlap in symptoms, as well as comparing severity of symptoms, extra-vigilance to symptoms, illness perception and illness behaviour of patients, who preferably not only report food intolerance or IBS, but also both food intolerance and IBS together. This approach would also aim to provide some indication of whether somatosensory amplification, previously described as a predisposing condition that leads to perceived food intolerance through the process of somatisation, may be a result of the experiencing of very severe symptoms, rather than a cause of the condition and its symptoms.

6. **Aims of the Thesis:**

The reported discrepancy between perceived and actual food intolerance, as well as an emerging trend in modern health decision making towards self-diagnosis and self-management through the use of non-medically supervised exclusion diets, are subjects of increasing interest in the medical field. The literature review described in this chapter has revealed a cluster of studies that have investigated possible psychological mechanisms associated with perceived food intolerance. In addition to the mostly clinical nature of these studies, their research has been almost exclusively based on the possible contribution of psychogenic factors and their findings have shared an importance of the contribution of anxiety, negative affect and somatosensory amplification to the formation, perception and attribution of symptoms and illness beliefs. However, a more recent approach to the phenomenon of people attributing adverse symptoms to the consumption of some foods, the Australian population study of Golley at al. (2015), has found that the behaviour of symptomatic wheat avoidance was not associated with neuroticism, illness worry or illogical reasoning that assume psychological disturbance. It indicated that the avoidance of wheat was associated with lesser receptiveness to doctors' advice and an inclination towards alternative medical practices. These findings raise questions regarding the possible psychological mechanisms underlying the attribution of symptoms to particular foods and the decision processes leading to self-prescribed avoidance.

The aims of the thesis are summarised as follows:

- To extend understanding of the predictors of food avoidance in the Australian adult population beyond wheat avoidance to dairy avoidance. As part of that to investigate the symptoms, diagnoses and the potential for misattributions leading to self-prescribed food avoidance (Study 1).

- To explore and understand the associated symptoms, the sources of diagnosis, and the psychological predictors of reporting of non-medically diagnosed (NMD) and medically diagnosed (MD) food intolerances in the Australian population (Study 2).

- To explore whether somatosensory amplification described in previous research as a predisposing condition that leads to perceived food intolerance through the process of somatisation, is potentially a function of the experiencing of very severe symptoms, rather than a cause of the condition and its symptoms (Study 3).

Chapter 2. Exegesis

Preamble

The origins of this thesis lie in the findings of a national population survey on the motivations for the dietary avoidance of wheat-based products (Golley, Corsini, Topping, Morell, & Mohr, 2015). Key findings from that study revealed that a significant proportion of non-coeliac Australian adults were avoiding consumption of wheat for the alleviation of physical symptoms, which were predominantly gastrointestinal but not allergenic in nature, in the absence, for the most part, of a formal diagnosis. Also important was the finding that a large number of self-identified symptomatic wheat avoiders were also avoiding dairy foods. This pointed to a number of questions in need of further research.

Previous studies with mostly clinical populations, often with patients from specialty allergy clinics, have found associations between psychogenic factors such as anxiety, negative affect, and somatosensory amplification and the attribution of distressing symptoms to the consumption of certain foods (Lied et al., 2011; Lillestøl et al., 2010; Rix, Pearson, & Bentley, 1984; Berstad, Arslan, Lind, & Florvaag, 2005; Bell, Schwartz, Peterson, & Amend, 1993; Pearson, Rix, & Bentley, 1983). Contrary to these results, the findings of Golley et al. (2015) indicated that the avoidance of wheat for the alleviation of physical symptoms was not predicted by neuroticism or an illogical reasoning style. Instead, the decision to avoid wheat appeared to be influenced substantially by information from non-medical sources, and was predicted by increased receptiveness to complementary medicine and lesser receptiveness to conventional medicine.

The findings of Golley et al. (2015) are of central importance to this thesis. They raise questions regarding the nature of the role played by anxiety and

negative affect in the avoidance of certain foods or food components for the alleviation of symptoms as suggested by earlier studies using clinical samples (Lied et al. 2011; Berstad et al., 2005; Lillestøl et al., 2010; Bell et al., 1993; Rix et al., 1984; Pearson et al., 1983; Lind et al., 2010). The results also directed attention to a gap in the literature, namely the need for larger population studies to examine the possible psychological mechanisms underlying the decision processes leading to self-prescribed avoidance of other food(s). The findings also prompted questions regarding the potentially discrete or intrinsically related nature of these avoidances. In addition, they raised questions regarding the attribution of symptoms, by which individuals arrive at the belief that they have an intolerance or sensitivity to certain foods in the absence of formal medical diagnosis.

To address these questions, three studies were conducted which are summarised below.

The first study of the thesis (Paper 1), used data collected through the CSIRO 2010 Food and Health Survey, which included sections for the avoidance of wheat and dairy containing products. The wheat avoidance section had been reported previously in Golley et al. (2015). The section on the avoidance of dairy products, which consisted of an identical set of questions, was the focus of Study 1. The study represented a follow-up investigation of the prevalence of and explanations for dairy avoidance, including reported symptoms, diagnoses and influences on the decision to avoid, as well as explored psychological predictors (psychogenic and non-psychogenic) of dairy avoidance behaviour.

Following on from the first study, Study 2 aimed to provide insights into the psychological characteristics which may predispose some individuals to interpret the cause of distressing symptoms as being the result of an intolerance or sensitivity to certain foods in the absence of formal medical

diagnosis. The measures of psychological individual differences in this study also included somatosensory amplification tendency as a measure of excessive vigilance for symptoms, which has previously been suggested by clinical research to have a significant role in the cause, maintenance, and exacerbation of symptoms of perceived (as opposed to actual) intolerance.

In the final study, Study 3, the potential role for somatosensory amplification or somatisation in the perception and maintenance of food intolerance was further investigated. The aim of study 3 was to consider the symptom profile and psychological characteristics associated with food intolerance in the context of those associated with IBS – a functional somatic syndrome. The study, which originated in Adelaide, was also designed with the help of the Health and Cognition Laboratory of the Department of Experimental Psychology in Oxford, UK, during four months (2015) of a research placement. It has benefitted from the laboratory's substantial experience in underlying cognitive mechanisms in IBS and other psychosomatic disorders.

This chapter is designed to help the reader in following the progression of the research program, as well as that of the research papers, which have been written as stand-alone manuscripts and prepared for publication in peer-reviewed journals. It will briefly preview each of the papers in an effort to explain how they flow from one to another, prior to their full reading.

Study (Paper) Summaries

Study 1 (Paper 1). Food avoidance in an Australian adult population sample: the case of dairy products

The data for this study were obtained through the Commonwealth Scientific and industrial Research Organisation's (CSIRO) postal 2010 – 11 Food and Health Survey. Study 1 investigated the prevalence and explanations for the avoidance of dairy foods in the Australian adult population, including reported symptoms, diagnoses and influences, as well as possible

psychological predictors of dairy avoidance. It also explored comparisons of symptomatic dairy avoidance with symptomatic wheat avoidance in the same sample, in order to understand whether these avoidances have different or similar predictive profiles, and are therefore to be regarded as discrete or intrinsically related phenomena.

Prediction of dairy avoidance was evaluated from attitudes to conventional and alternative treatments, measures of cognitive style (rational versus intuitive), psychopathological factors (illness worry), personality (levels of neuroticism), locus of control, current health status and diagnoses, and personal or demographic details such as gender, age and educational level. Special attention was given to investigating whether the null effects for neuroticism, illness worry or irrational or emotional reasoning styles found in the wheat avoidance study of Golley et al., (2015) applied with respect to symptomatic dairy avoiders. Replicating these findings would again, contradict previous research with mostly clinical samples, which has found an increased incidence of psychiatric disorder amongst patients, attributing adverse symptoms to food intolerance.

The results showed that of the 1184 participants who returned the completed questionnaires, 188 were currently avoiding dairy products, and of those 139 reported adverse symptoms as the reason for avoiding. People with formally diagnosed coeliac disease ($n = 9$) were excluded from further analysis. All subsequent analysis focussed on the remaining n=130 symptomatic dairy avoiders, the majority of whom were women. Symptomatic dairy avoiders, including those who also avoided wheat, reported adverse symptoms, mostly of gastrointestinal nature. Responses on questions regarding past diagnoses indicated that symptomatic avoiders of dairy, wheat or both often reported having been diagnosed at some time with food intolerance or allergy, as well as with IBS. The avoidance of dairy

foods for alleviation of adverse symptoms by people not also avoiding wheat was predicted by lesser age and increased worry about illness, and occurred overwhelmingly without a formal medical diagnosis or recommendation.

The findings of Study 1 are further evidence of the widespread tendency for people to eliminate dietary factors without medical diagnosis or recommendation. The results emphasized the need for a follow-up investigation of the psychological characteristics predicting this behaviour and resulting in potential misattribution of symptoms. In addition, the tendency for dairy avoidance (unlike wheat avoidance) to be associated with more worry about illness was a reminder that symptom-related psychological distress might be a response rather than antecedent to symptoms. Worry about illness, as a form of health anxiety of which hypochondriasis is an extreme state, in addition to having been thought of as originating from psychodynamic, interpersonal, and behavioural perspectives, has also been described as a disorder of perception and cognition (Barsky & Klerman, 1983). Hypochondriasis has been associated with somatosensory amplification, as it has been found to involve a heightened sensitivity to benign bodily dysfunction and normal physiology (Barsky, Wyshak, & Klerman, 1990). It has been suggested that hypochondriacs amplify normal physiological sensations, and because their symptoms are intense, they mistakenly conclude that they are abnormal and pathological. Therefore, the particular association of dairy avoidance with worry about illness directed attention to the question of whether a phenomenon like somatosensory amplification, is peculiar to non-medically diagnosed (perceived) food intolerances, as often suggested by clinical research, or also observed in cases of medically diagnosed food intolerance. This question formed an important topic for the next step of investigation.

In summary, the results of Study 1 revealed a strong connection between ingestion of wheat and dairy products and symptoms, non-medical diagnosis

and self-management of these symptoms and their labelling by some avoiders as an intolerance. These findings raised questions regarding the individual-level characteristics that may predispose individuals to attribute distressing symptoms to the consumption of certain foods and, without supporting evidence from expert diagnosticians, to subsequently label themselves as food intolerant. In addition, they directed attention to the possible contribution of illness worry to the amplification and misattribution of these symptoms.

Study 2 (Paper 2). Prevalence and psychological predictors of medically and non-medically diagnosed intolerance in Australia.

Study 2 was designed as an Australian population study, data for which were obtained through a national postal omnibus Food and Health Survey conducted by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) between December 2013 and February 2014. The survey assessed attitudes and behaviours in response to health, foods, and food characteristics. A section in the survey specifically asked questions about allergies or intolerances, sources of diagnoses and symptoms associated with these intolerances, and examined the psychological predictors for reporting both medically diagnosed (MD) and non-medically diagnosed (NMD) food intolerance. The psychological characteristics considered as predictors in the study included somatosensory amplification tendency, as a measure for extra vigilance for symptoms, personality characteristics, namely neuroticism and conscientiousness, health locus of control, propensity for a less analytical and/or more intuitive reasoning style, receptiveness to complementary and alternative medicine (CAM) and to conventional medicine, respectively, and past diagnoses. Personal or demographic details such as gender, age and educational level were included.

Of 938 participants who completed the questionnaires, 186 (19.8%) reported having one or more food allergies or intolerances/sensitivities. Approximately three quarters of people reporting intolerances, (or approximately 14.6% of the sample) reported non-medically diagnosed intolerances: intolerances that were either CAM diagnosed, or otherwise not formally diagnosed. The most commonly reported symptoms were gastrointestinal problems.

Overall, the tendency to report having either a medically diagnosed or a non-medically diagnosed intolerance, was significantly predicted by somatosensory amplification tendency and a locus of control involving rejection of powerful others. Having a medically diagnosed intolerance was also predicted by need for cognition (negatively) and by an increased receptiveness to conventional medicine. Having a non-medically diagnosed intolerance was significantly predicted by increased receptiveness to complementary and alternative medicine.

Null effects for neuroticism for non-medically (as for medically) diagnosed intolerances were again inconsistent with the central role of anxiety and negative affect suggested by studies, mostly of clinical samples (Lied et al., 2011; Lillestøl et al, 2010; Pearson et al, 1983; Rief & Broadbent, 2007). These studies have associated perceived food intolerance with psychogenic factors, which are thought to contribute to somatization mechanisms of heightened perception and misattribution of bodily symptoms. The results of Study 2 raised the possibility that somatosensory amplification, in appearing to be associated with the understanding that one has a food intolerance - medically supported as well as unsupported - is an unremarkable consequence of the belief that the ingestion of certain foods results in particular physical reactions, rather than a cause of the condition and its symptoms.

A direction for future research was suggested by the proposal that the tendencies described as somatosensory amplification – extra-vigilance and the tendency to amplify symptoms – may be a consequence rather than necessarily a cause of a presumed intolerance and severity of the symptoms experienced. This identified, as a next step for investigation in Study 3, the need to explore possible somatisation mechanisms behind reported severe reactions to symptoms in perceived food intolerance. These mechanisms, which include severity of symptoms, somatosensory amplification, illness perception and illness behaviour were to be investigated specifically in the context of a functional somatic syndrome, such as IBS, where for its pathogenesis they have been regarded as important.

Study 3 (Paper 3). IBS and food intolerance: differences in somatic symptom severity, somatosensory amplification and illness perception.

The results of Study 2 indicated that reporting food intolerance – whether with or without a supporting medical diagnosis – was predicted by greater somatosensory amplification tendency compared to the rest of the population. This raised the possibility that the tendency to be sensitised to and vigilant in respect to symptoms and to experience bodily sensations as more intense, noxious, and disturbing, is associated with the understanding that one has a food intolerance (medically supported as well as unsupported) and may be a consequence rather than a cause of the condition and its symptoms. The mechanisms that underpin the reactions to symptoms in perceived food intolerance became of significant interest to this thesis and were investigated in study 3.

A few important points have added to the research hypothesis in this study. Firstly, lack of consistent findings in the literature regarding significant associations between food intolerance and psychogenic factors has cast

doubt on the role of anxiety and negative affect on the perception, severity, and maintenance of symptoms, suggested by studies of clinical samples. Secondly, it has been noted that perceived food intolerance is highly prevalent among subjects with IBS (up to 84%) (Böhn, Storsrud, Tornblom, Bengtsson, & Simren, 2013; Simrén et al., 2001; Nanda, James, Smith, Dudley & Jewel, 1989; Dainese, Galliani, Lazzari, Di Leo, & Naccarato, 1999). Thirdly, most of the reported symptoms of food intolerance have been thought as identical with the symptoms of Irritable Bowel Syndrome, which range from gastrointestinal symptoms to extra-intestinal symptoms (somatic complaints), such as headache, back pain, fatigue, poor sleep, shortness of breath, muscle or joint aches or pain (Surawy, Hackmann, Hawton, & Sharpe, 1995; Frissora & Koch, 2005). Previous research has also frequently identified persistent somatisation, high dissatisfaction with health, low pain threshold, visceral hypersensitivity and somatic amplification (Porcelli, 2004; Wood & Mertz, 2003; Kanazawa, Hongo, & Fukudo, 2011), leading to symptoms, high in frequency and severity, as characteristics of IBS patients (Surawy et al., 1995; Frissora & Koch, 2005; Porcelli, 2004).

Broadly, study 3 aimed to explore whether somatization mechanisms including severe symptoms, extra-vigilance, amplification and misattribution of bodily symptoms, previously associated with reporting of food intolerance, may instead be responses to the presence of IBS-like symptoms and an IBS diagnosis.

The study investigated the hypothesis that patients reporting food intolerance would differ from IBS patients and patients reporting both IBS and food intolerance in (a) symptom severity, (b) somatosensory amplification tendency, as a measure of extra-vigilance, (c) perception of severity of illness, and (d) illness behaviour. The study also explored whether there were any significant differences between the patients on other psychological features, including health locus of control, anxiety and

depression, receptiveness to complementary and alternative medicine and receptiveness to conventional medicine.

Participants were recruited from GP practices and allergy and food intolerance clinics for a cross-sectional survey of the psychological and demographic characteristics of adult patients reporting food intolerance and/or IBS. The sample consisted of adults, aged 18 years and over: 14 IBS patients, 21 patients with food intolerance (FI) and 15 patients who reported having both food intolerance and IBS (FI + IBS). Of the 50 participants, 44 were female.

The results supported the study hypothesis in the following ways: First, they showed that more than half of the IBS patients reported concurrent food intolerance. This confirmed the high prevalence of food intolerance amongst IBS patients, as reported in previous studies (Böhn et al., 2013; Simren et al., 2001; Nanda et al., 1989). Secondly, participants reporting IBS or both IBS and food intolerance reported significantly more severe symptoms and scored significantly higher on somatosensory amplification tendency than those reporting food intolerance only. This suggests that the high number of severe, disturbing symptoms accompany a state of health of which a diagnosis of IBS is a marker, and are not peculiar to the perception that one has a food intolerance. Thirdly, the ratings from the illness perception questionnaire for each condition - food intolerance and IBS, within the group reporting both food intolerance and IBS, indicated that food intolerance was perceived as more benign and less threatening than IBS.

A limitation of this study is its limited statistical power due to a modest clinical sample size. In addition, the cross-sectional study design has limited the ability to interpret the direction of causation of the found associations. A longitudinal study would have provided a better understanding of these

questions, however the repetition in conducting such a study could be costly and time-consuming, making it impractical for the purposes of this thesis.

Overall comments on the collection of papers

The series of papers written as part of this thesis provide insights into several important phenomena. They provide information previously unavailable in Australia on the practice of eliminating foods, or food components, and its true prevalence and psychological aetiology. This research was the first to investigate psychogenic and non-psychogenic factors in not only perceived, but also medically diagnosed food intolerances in a non-clinical community population.

From the findings of this thesis, perceived food intolerance appears to be a phenomenon, unlikely the result of psychiatric illness or personality disorder. From the third study there is also evidence suggesting that attributing adverse symptoms to specific foods is unlikely to be due to psychosomatic reactions, of the kind observed in functional somatic syndromes. The overall impression is that a significant number of people with perceived food intolerance do not seek medical advice regarding their symptoms, and treat themselves by eliminating the foods in question from their diets. The origins of this behaviour appear to fall largely outside the mainstream medicinal practice, with significant adherence to complementary and alternative medicine, and notable rejection of doctor's advice.

The results, conclusions and implications of each study are discussed in the individual manuscripts. Chapter 6 provides a conclusion and discussion of the overall aims and findings of this thesis.

Statement of Authorship

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Contribution to the Paper	I was responsible for performing all statistical analyses, interpretation of the results, and wrote the manuscript with input from all co-authors.
Overall percentage (%)	60%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
Signature	Date 10/10/16

Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

i. the candidate's stated contribution to the publication is accurate (as detailed above);

ii. permission is granted for the candidate in include the publication in the thesis; and

iii. the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Chapter 3. Food avoidance in an Australian adult population sample: the case of dairy products

Abstract

Objective: To assess the prevalence of and explanations for the avoidance of dairy foods, including symptoms attributed to their consumption, diagnoses, and psychological predictors of avoidance. Also considered were comparisons with symptom-related avoidance of wheat in the same sample.

Design: Cross-sectional population survey

Setting: The study was conducted in Australia using a national postal omnibus survey.

Subjects: Adults aged 18 years and over (N = 1184; 52·9% female) selected at random from the Australian Electoral Roll.

Results: Despite few claims of formally diagnosed allergy or intolerance, 11·8% of the sample reported avoiding dairy products because of adverse physiological effects, which commonly included gastrointestinal symptoms. Unlike wheat (3·5%) or wheat-and-dairy (3·6%) avoidance, dairy avoidance (8·2%) was predicted by age (negatively) and worry about illness (positively).

Conclusions: The findings are further evidence of a widespread tendency for consumers to exercise control over their health by eliminating dietary factors considered suspect without medical evidence or oversight. Unanswered questions include the decision processes underlying dairy avoidance, whether symptoms are attributed correctly, the agents and physiological mechanism(s) involved, the relative contributions of symptom severity and vigilance to the association with illness worry, and the nutritional adequacy of dairy avoiders' diets. Irrespective of the accuracy of

self-diagnoses, if the elimination of suspect foods is an end in itself the paradoxical possibility for nutritional imbalances may have significant public health implications.

Introduction

The benefits of the consumption of dairy foods are numerous. They are the biggest source of calcium in the Australian diet and whole milk and other dairy foods provide a unique package of other essential nutrients including protein, vitamins (A, B12 and riboflavin) and minerals (phosphorus, magnesium, potassium and zinc) [1]. Not consuming these foods risks insufficient dietary calcium intake and has been known to result in reduced bone mineral density, increased incidence of fracture, and other risks to health and well-being [1; 2; 3].

National information about the prevalence and drivers of avoidance of dairy products is scarce in Australia. The Australian Bureau of Statistics reported that in 2011-12, 17% of Australians aged 2 years or over (3·7 million people) reported avoiding a food due to allergy or intolerance, cow's milk and other dairy products (4·5%) being the most commonly claimed source of intolerance [4]. Because these figures relate only to cases of food avoidance specifically attributed by interviewees to an allergy or intolerance, they can be expected to underestimate – perhaps substantially – the population prevalence of avoidance of any given food, including dairy foods.

In a national population survey, 7% of apparently non-coeliac Australian adults reported avoiding consumption of products containing wheat for the alleviation of physical symptoms. In the great majority of cases, these related to the gastro-intestinal system and included those that are diagnostic of irritable bowel syndrome (IBS) according to the ROME 2 criteria. Wheat avoidance occurred overwhelmingly in the absence of a formal diagnosis and was predicted by receptiveness to complementary medicine (positively) and conventional medicine (negatively) but not by measures of anxiety or illogical reasoning style. Questions arising from these findings relate, inter alia, to the possible physiological mechanisms underlying symptoms, the decision processes leading to self-prescribed avoidance of wheat, and the potential for nutritional imbalances [5].

Compounding these questions, however, is the additional finding that 52% of self-identified symptomatic wheat avoiders also reported, in a separate sub-section of the same omnibus survey, that they were avoiding consuming dairy foods. This points to a possibly widespread phenomenon of poly-avoidance with significant implications for both the development of nutritional imbalances – through the compensatory over-consumption of other foods as well as the avoidance – and the task of identifying a specific food component as a source of symptoms. Where wheat avoidance and dairy avoidance are concerned, it also prompts the question whether these are discrete or intrinsically related phenomena.

Using data from the same survey, the present paper addresses the prevalence and explanations for dairy avoidance, including reported symptoms, diagnoses, and influences, as well as possible psychological predictors of and health conditions correlated with dairy avoidance behaviour. This is the same set of measures as used in the wheat avoidance study [5]. The psychological characteristics considered thus include neuroticism, tendency to worry about illness, propensity for a less analytical and/or more intuitive reasoning style, and receptiveness to each of conventional and complementary medicine. Of key interest throughout are commonalities with and differences from the case of wheat avoidance.

Method

Participants and study design

Data for this study were obtained from a cross-sectional survey of attitudes and behaviours related to health, diet, foods, and food characteristics in an adult Australian population sample selected at random from the Australian Electoral Roll. The data were collected through the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) 2010-11 Food and Health Survey. Detailed data collection methods and procedure are described

elsewhere [5]. One thousand one hundred and eighty-four of a possible 2867 postal surveys were returned completed (an overall response rate of 41·3%). The sample consisted of adults aged 18 years and over: 527 males (44·5%), 626 females (52·9%) and thirty-one not specified (2·6%); mean reported age was 51·64 (sd 16·78) years. Women (χ^2 (1, n 1148) = 6·02, p = 0·01] and older people χ^2 (6, n 1144) = 149·78, $p < 0·01$) were over-represented relative to the population; the data were weighted to adjust for this in the calculation of population prevalence estimates.

Procedure

The CSIRO Food and Health Survey was a 200-item postal omnibus survey distributed nationally in December 2010; participation was anonymous. The study was conducted according to the guidelines laid down by the Declaration of Helsinki, and the research protocol was approved by the CSIRO Human Research Ethics Committee.

Variables

The questionnaire contained a section labelled "Avoidance of wheat and /or dairy products". Responses to the avoidance of wheat products are reported elsewhere [5]; an identical set of questions addressing the avoidance of dairy products is the focus of this paper. Questions asked whether they avoided all or certain dairy products and to specify which; to state the main reason for avoiding the consumption; to identify any reactions to dairy consumption from a list of 18 physiological and psychological symptoms; to indicate on a three-point scale ('not at all', 'somewhat', 'very much') the extent to which each of seven medical or non-medical sources of recommendation or information had contributed to their decision to avoid dairy; and to identify any formally diagnosed condition that required them to avoid dairy.

Other sections of the survey provided the following measures. Neuroticism, a personality dimension characterised by anxiety and negative emotions, was measured with nine items from the NEO-N Domain [6]. Participants rated statements (e.g., I panic easily) on a five-point scale, where 1 = 'completely false' and 5 = 'completely true'. Reasoning style was assessed by the Rational-Experiential Inventory (REI) [7], comprising five items drawn from each of the Need for Cognition [8] and Faith in Intuition Scales [7], each item employing a five-point scale from 'completely false' to 'completely true'. Higher scores represent increased reliance on analytical and intuitive reasoning for each scale, respectively.

In a section addressing general health, participants were asked to identify past diagnoses from a list of twelve conditions. Illness worry was measured with four items from the Whitely Index for the assessment of hypochondriasis (e.g., 'Do you often worry about the possibility that you have got a serious illness?')[9]. Receptiveness to conventional medicine (four items) and complementary medicine (six items) were assessed by ratings of the likelihood of taking certain actions for health matters (e.g., Consult a doctor', 'Consult a naturopath'). Responses were measured on a scale from 1 = 'definitely not' to 7 = 'definitely'.

Statistical analyses

Prior to analyses, the pattern of missing data for the continuous variables was investigated with the Missing Values Analysis module in SPSS version 20. Little's MCAR test [10] showed that the data were missing completely at random (χ^2 = 28701·40, df = 28818, p = ·69); consequently, missing values were imputed using the expectation maximization (EM) algorithm. Descriptive statistics were calculated to provide frequency distributions and cross-tabulations of key variables. The chi-square test of independence and Fisher's exact test, as appropriate [11], were used to examine associations

between categorical variables. Predictors of avoidance were assessed by means of multivariable logistic regression. Pearson point-biserial correlations were calculated for bivariate associations between continuous and dichotomous variables, and group differences in ratings of sources of influence were assessed with one-way analyses of variance.

The statistical package SPSS versions 20-22 (IBM Corp, Armonk, NY) was used for all analyses.

Results

Preliminary analyses

Of the 1184 participants who returned the completed questionnaires, 188 (15·9% unweighted, 16·6 % weighted of the sample) indicated that they were currently avoiding dairy products (70 men, 115 women, and three of undisclosed gender). Of this number, 15 (1·3% unweighted, 1·3% weighted) reported avoiding dairy products because of a medically diagnosed condition, mostly cardiovascular, and 34 (2·9% unweighted, 3·4% weighted) gave diverse reasons unrelated to symptoms or diagnosed conditions. Explanations given included concerns about levels of saturated fat, personal dislike of taste, calorie and weight management, and the view that dairy foods were not appropriate for human adult consumption.

The remaining 139 (11·7% unweighted, 12·6% weighted) reported symptoms and negative reactions to the consumption of dairy products, including nine people (0·8%) who reported having been formally diagnosed with coeliac disease. All subsequent analyses focused on the remaining 130 (11% unweighted, 11·8% weighted) symptomatic dairy avoiders: 82 (63·1%) women, 45 (34·6%) men, and three (2·3%) of unknown gender.

Main analyses

Of this symptomatic dairy-avoiding group, 78 (60%) nominated physical reactions as their main reason for avoiding dairy foods, 25 (19·2%) nominated intolerance or allergy, 5 (3·9%) gave various other reasons, and 22 (16·9%) gave no reason. Partial dairy avoidance (n = 98; 75·4%) was reported more frequently than full avoidance (n = 29; 22·3%). The foods most commonly nominated by partial avoiders were milk (55·4%), cheese (16·9%), and cream (16·2%).

Thirty (23·1%) symptomatic dairy avoiders reported having a formal diagnosis that required them to avoid dairy. The diagnoses were reported as lactose intolerance (5; 3·8%), high cholesterol (6; 4·6%), asthma (4; 3·1%), allergy (3; 2·3%), IBS (3; 2·3%), diabetes (2; 1·5%), and several unique responses.

Symptoms reported

The most commonly reported reactions involved gastrointestinal discomfort, with 62·3% indicating either "stomach discomfort or cramps" or "bloating or wind"; also common were diarrhoea and mucus build-up. Table 1 lists the frequency of occurrence of all 18 symptoms; these did not differ significantly between self-reported complete and partial avoiders.

Table 1 Frequency and type of symptoms reported by symptomatic dairy avoiders (*n*=130); CSIRO Food and Health Survey, Australia, December 2010 – February 2011

Reported Symptoms	Total	
	n	%
Stomach discomfort or cramps	66	50·8
Bloating or wind	57	43·8
Diarrhoea	48	36·9
Mucus build-up	46	35·4
Feeling sluggish or tired	22	16·9
Vomiting or nausea	21	16·2
Constipation	19	14·6
Heartburn or indigestion	18	13·8
Skin problems	15	11·5
Sleep disturbance	13	10·0
Headaches	13	10·0
Breathing problems	7	5·4
Body aches and pains	7	5·4
Feeling anxious or irritable	4	3·1
Sweating	4	3·1
Hives	4	3·1
Feeling restless or hyperactive	1	0·8
Feeling sad or blue	0	0·0

Note: Multiple responses allowed

The cross-tabulation of dairy avoidance with wheat avoidance data identified 45 symptomatic wheat avoiders (SWA; 3·8% unweighted, 3·5% weighted), 88 symptomatic dairy avoiders (SDA; 7·4% unweighted, 8·2% weighted), and 42 symptomatic wheat-and-dairy avoiders (SWDA; 3·6%), the latter representing 32·3% of the 130 symptomatic dairy avoiders. Figure 1 summarises the classification of participants.

Figure 1 Flow-chart of the classification of self-reported avoiders of dairy products and wheat products; CSIRO Food and Health Survey, Australia, December 2010-February 2011
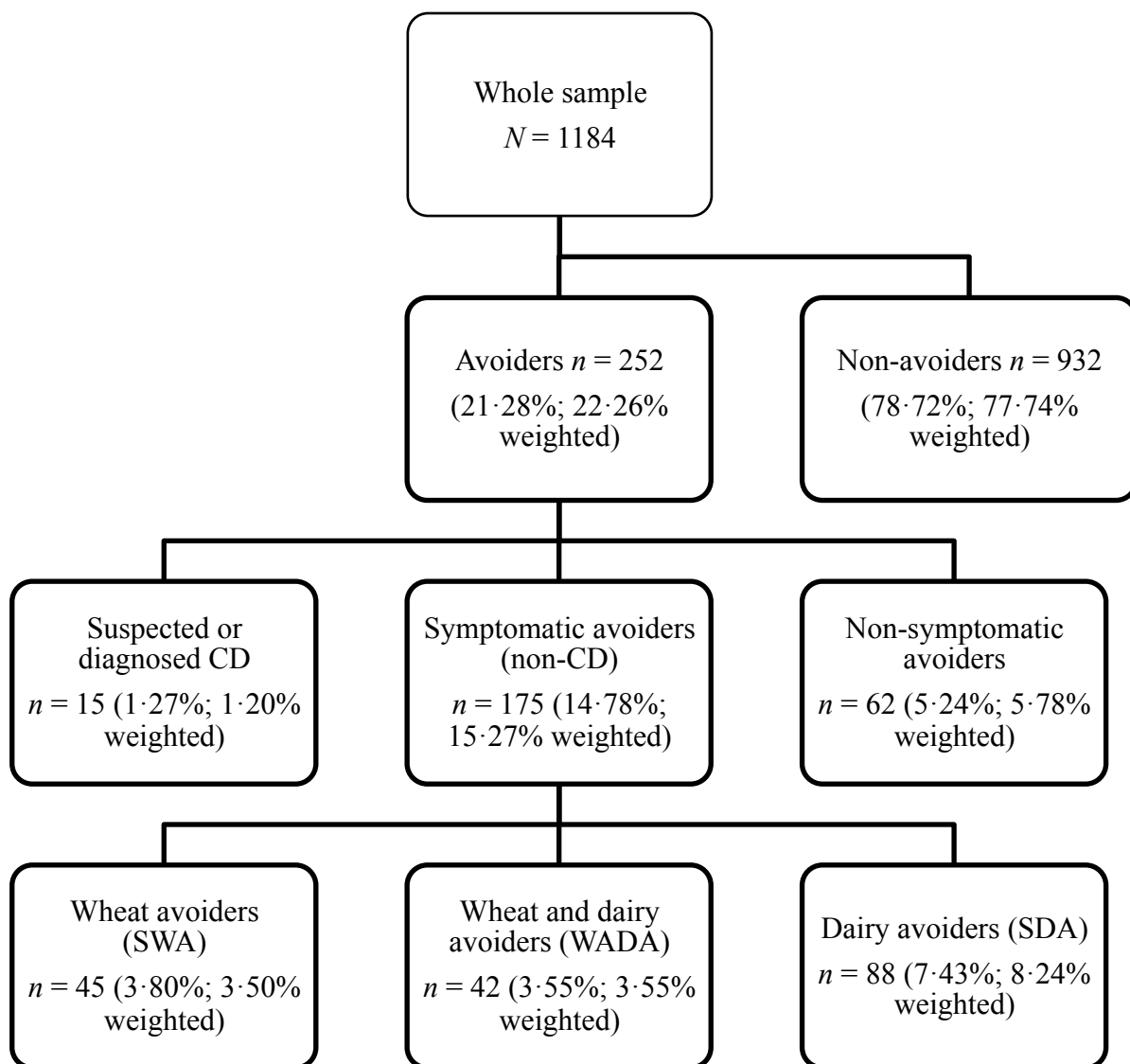
Table 2 reports a comparison of categories of symptoms attributed to wheat and dairy by avoiders of either, but not both. Relative to wheat, dairy was less frequently associated with gastrointestinal symptoms (χ^2 = 5·94, p = ·015) and tiredness (χ^2 = 7·68, p = ·006) and more frequently associated with mucus production (χ^2 = 13·61, p < ·001). Further comparisons showed that wheat-and-dairy avoiders were more likely than wheat avoiders to attribute mucus production (23·8%; χ^2 = 9·17, p = ·007) to wheat and more likely than dairy avoiders to attribute tiredness (31%; χ^2 = 8·69, p = ·007) and skin problems or hives (23·8%; χ^2 = 9·15, p = ·004) to dairy. There were no other group differences.

Table 2 Summary of symptoms reported by avoiders of wheat (n = 45) and dairy (n = 88); CSIRO Food and Health Survey, Australia, December 2010 – February 2011

Symptoms	Wheat avoiders	Dairy avoiders
Gastrointestinal*	43 (95·6%)	68 (77·3%)
Nausea and vomiting	3 (6·7%)	12 (13·6%)
Skin problems or hives	5 (11·1%)	5 (5·7%)
Breathing problems	1 (2·2%)	4 (4·5%)
Sweating	2 (4·4%)	3 (3·4%)
Head or body aches	6 (13·3%)	11 (12·5%)
Behavioural	9 (20%)	11 (12·5%)
Mucus**	1 (2·2%)	28 (31·8%)
Sluggish or tired*	14 (31·1%)	9 (10·2%)

Note: *p < 0·05; **p < 0·001

Gastrointestinal = Stomach discomfort or cramps; Bloating or wind; Diarrhoea; Constipation; or Heartburn or indigestion.

Behavioural = Feeling anxious or irritable; Feeling restless or hyperactive; or Feeling sad or blue.

Table 3 shows the results of a multivariable logistic regression for the prediction of membership of the three avoidance categories relative to the rest of the sample (*n* = 994), coeliac cases excluded. Symptomatic wheat avoidance was significantly predicted by gender (being female) and receptiveness to complementary medicine. A negative association with receptiveness to conventional medicine approached statistical significance. Symptomatic avoidance of both wheat and dairy products was similarly predicted by being female, more receptive to complementary medicine and less receptive to conventional medicine. Symptomatic dairy avoidance was significantly predicted by age (negatively) and worry about illness. Follow-up Pearson point-biserial correlations revealed no significant associations between illness worry and a particular symptom or symptoms.

Table 3 Multivariable logistic regression of predictors of symptomatic wheat avoidance, symptomatic dairy avoidance, symptomatic wheat and dairy avoidance; CSIRO Food and Health Survey, Australia, December 2010 – February 2011

						95% CI for OR	
						Lower	Upper
Predictors	β	SE	Wald	*P*	OR		
SWA vs. The Rest of the Sample							
Receptiveness to complementary medicine	·49	·16	9·14	0·002	1·64	1·19	2·26
Sex	-1·36	·41	11·17	0·001	·26	·12	·57
Receptiveness to conventional medicine	-·29	·15	3·73	0·053	·75	·56	1·00

Age	·01	·01	·94	0·333	1·01	·99	1·03
Analytical thinking style	·22	·21	1·09	0·297	1·24	·83	1·88
Intuitive thinking style	·13	·23	·32	0·575	1·14	·73	1·77
Neuroticism	-·40	·28	2·11	0·147	·67	·39	1·15
Illness worry	·09	·20	·19	0·662	1·09	·73	1·63
SDA vs. The Rest of the Sample							
Receptiveness to complementary medicine	·12	·12	1·13	0·288	1·13	·90	1·42
Sex	-·09	·24	·16	0·692	·91	·57	1·45
Receptiveness to conventional medicine	-·08	·12	·42	0·519	·93	·73	1·17
Age	-·02	·01	5·99	0·014	·98	·97	·99
Analytical thinking style	·09	·15	·33	0·568	1·09	·81	1·47
Intuitive thinking style	-·13	·16	·64	0·423	·88	·65	1·20
Neuroticism	·05	·18	·07	0·799	1·05	·74	1·49
Illness Worry	·30	·14	4·78	0·029	1·35	1·03	1·78
SWDA vs. The rest of the Sample							
Receptiveness to complementary medicine	·48	·17	8·21	0·004	1·62	1·16	2·25
Sex	-1·30	·42	9·72	0·002	·27	·12	·62
Receptiveness to conventional medicine	-.62	.14	18.52	0.000	·54	·41	·71
Age	·01	·01	·89	0·345	1·01	·99	1·03
Analytical thinking style	·40	·22	3·30	0·069	1·49	·97	2·30

Intuitive thinking style	·07	·23	·10	0·753	1·08	·69	1·69
Neuroticism	-·03	·27	·02	0·901	·97	·57	1·65
Illness worry	·30	·21	2·10	0·147	1·35	·90	2·01

Note:

Model χ^2 = 90·42, p < 0·001

N = 1184

Analyses involved a four-level classification of the sample as: symptomatic wheat avoiders (SWA), symptomatic dairy avoiders (SDA), symptomatic wheat-and-dairy avoiders SWDA), and the rest of the sample.

Table 4 shows the frequencies of past diagnoses reported by members of the three groups of avoiders relative to the rest of the (non-coeliac) sample. For each of the avoidance categories, membership was associated with increased reporting of a past diagnosis of food intolerance or allergy; for the SDA group, it was also associated with more reports of irritable bowel syndrome (IBS) and of chronic fatigue syndrome (CFS) and, for the SWDA group, more reports of IBS and of depression.

Table 4 Diagnosed conditions reported by symptomatic dairy avoiders (SDA), symptomatic wheat avoiders (SWA), symptomatic wheat-and-dairy avoiders (SWDA), and the rest of the sample with cases of coeliac disease excluded; CSIRO Food and Health Survey, Australia, December 2010-February 2011

	SDA	SWA	SWDA	Rest of the sample
	n (%)	n (%)	n (%)	n (%)
Heart disease and/or stroke	5 (6·0)	5 (11·6)	5 (12·5)	114 (11.8)
Diabetes	6 (7·1)	3 (7·0)	2 (5·0)	63 (6.5)
Obesity	10 (12·2)	4 (9·8)	2 (5·1)	96 (10.0)
Bowel or Colorectal Cancer	1 (1·2)	0 (0·0)	1 (2·5)	22 (2·3)
Irritable Bowel Syndrome	13 (15·3)*	7 (16·7)	10 (26·3)**	78 (8.1)
Inflammatory Bowel Disease	4 (4·7)	2 (4·7)	3 (7·7)	24 (2.5)
Chronic Fatigue Syndrome	7 (8·2)*	2 (4·7)	2 (5·1)	22 (2.3)
Asthma	14 (16·5)	11 (25·6)	9 (22·5)	166 (17.4)
Depression	23 (27·1)	12 (27·9)	15 (38·5)*	180 (18.8)
Food sensitivity or allergy	33 (37·5)**	16 (35·6)*	17 (40·5)**	79 (7.9)

Note: * χ^2 significant at <0·05 level; ** χ^2 significant at < 0·001 level

One-way analyses of variance were conducted to compare the ratings by the three avoidance groups of possible sources of influence on the decision to avoid. The sources of influence were defined as Medical (mean of Doctor and Other Specialist ratings), Complementary Medicine (mean of Naturopath and Other Complementary Medicine ratings), Family and friends, and Media (mean of Internet and Media ratings). For the SWDA group, who completed influence ratings for both wheat avoidance and dairy avoidance, scores were further calculated as the mean of those ratings. Results showed a significant

group difference for Complementary Medicine (F (2,157) = 6·06, p = ·003; Tukey post-hoc comparisons indicated that rated influence of complementary medicine sources was significantly lower for the SDA group (M = 1·31, SD = ·54) than for the SWDA group (M = 1·74, SD = ·76) but not the SWA group (M = 1·46, SD = ·63).

Discussion

The survey data indicate that a substantial number of the Australian adult population are avoiding dairy foods. At 16·6% (population-weighted by age and gender), the prevalence of dairy avoidance reported is 55% greater than was observed for wheat[5]. The explanations provided for the behaviour include various idiosyncratic factors (3·4%), management of several (mainly cardiovascular) diagnosed medical conditions (1·3%), and coeliac disease (0·8%). However, of most interest here is the remaining 11·8% of the sample, which attributed symptoms and negative reactions to the consumption of dairy foods. Almost a third (3·6%) of this symptomatic group also reported avoiding wheat products for alleviation of symptoms. Together with wheat-only (3·5%) and dairy-only (8·2%) avoiders, they put the combined prevalence of (ostensibly non-coeliac) symptomatic avoiders of either dietary factor at 15·3%.

Symptoms, diagnoses, and the potential for misattributions

Milk and wheat both contain components that can trigger adverse serious physiological reactions. Principally, these components are a disaccharide (lactose) and protein (gluten), respectively, and the intolerances that they trigger are diagnosed clinically. However, the avoidance of dairy foods for symptom control, as found previously for wheat [5], appeared to rely substantially on a non-medically diagnosed connection between ingestion and symptoms. Reports of a diagnosed allergy or intolerance mandating the

avoidance were similarly infrequent at 6.2% (0·7% of the sample). Avoiders of dairy foods cited gastrointestinal symptoms most commonly, though less consistently than was the case for wheat products. Fatigue was also cited less frequently and mucus build-up considerably more frequently for dairy than for wheat. Dairy products have often been blamed for increased oral and nasal mucus production, but these effects have not been substantiated by well–controlled studies [12; 13].

Although it would be unwise to attempt diagnoses on the basis of the present data, the symptoms claimed for dairy admit the possibility of undiagnosed dairy allergy or lactose intolerance. IBS-like symptoms may also reflect the involvement of poorly absorbed short-chain carbohydrates, other than lactose, which can induce gastro-intestinal discomfort through osmotic effects or rapid fermentation by the colonic microbiota. These carbohydrates (FODMAPS: fermentable oligo-saccharides, di-saccharides [lactose], mono-saccharides [fructose] and polyols)[14; 15] may be present in dairy products or in foods consumed with dairy products, and effects may be independent of or additive with lactose[16].

Reports of past diagnoses elicited independently of the question of food avoidance do not clarify the picture greatly. Symptomatic avoiders of dairy, wheat, or both often reported having at some time been diagnosed with a food intolerance or allergy despite the dearth of such reports specific to the avoidance behaviour. Unsurprisingly, reports of a previous diagnosis of IBS were also common. Dairy avoiders were also more likely than the average to report a past diagnosis of Chronic Fatigue Syndrome (CFS), although the numbers involved were still small. It has been proposed that a comorbid triad of perceived food intolerance, IBS, and fatigue might point to a common underlying cause [17], however a causal relationship between these conditions has not been ascertained. Causation is also unclear in the greater likelihood for dairy avoiders who also avoided wheat to report a past diagnosis of depression.

Whatever the causal agents and physiological factors that trigger the avoidance of dairy foods, the general lack of a formal diagnosis – reasons for which may range from negative test results to an absence of medical involvement – is a matter of serious public health concern. It has been proposed that health care professionals may recommend avoidance of dairy foods as a viable treatment option when they feel that they have little else to offer patients [18]. Self-diagnosed links between a dietary component and symptoms may derive from adverse publicity either directly or as a manifestation of categorical thinking about some foods as being intrinsically bad [19]. Although consumers may find justification for a dietary strategy in an apparent reduction in symptoms, confidence may be misplaced [20]. Non-specific gastrointestinal symptoms often attributed to intolerance have been found to be susceptible to the placebo effect associated with dietary manipulations [21; 22; 23; 24]. In short, the potential for misattribution of an underlying symptomatic state is clearly considerable.

Two populations of avoiders?

The similarities in symptoms and frequent co-occurrence of dairy avoidance and wheat avoidance prompt the question whether they are fundamentally two expressions of a single phenomenon. However, the different predictive profiles broadly suggest two avoidant populations: the one avoiding wheat and possibly also dairy foods and another avoiding dairy but not wheat foods. They also depict the two types of avoidance as substantially different psychosocial phenomena, with dairy avoidance tending to be associated with an internal focus on the possibility of illness rather than the external focus on treatment strategies evident in wheat avoidance.

Worry about illness may represent a position on a continuum of health anxiety of which hypochondriasis is an extreme and rare form [25; 26; 27; 28]. Concerns about the possibility of illness may be also be reactive, being

provoked by perceived unusual changes in bodily functioning, exposure to negative information about health that is personally significant, or (perhaps less plausibly here, given the null finding for neuroticism) bodily sensations that are catastrophically interpreted [29]. What cannot be determined, therefore, is to what degree dairy avoidance is the behaviour of a more symptom-vigilant population [30] or associated with more severe or distressing symptoms [31]. This is an important distinction and a question for further research.

Strengths, limitations, and public health implications

As discussed previously[5], the strengths of these survey data lie in the use of probability sampling from the national adult population and the potential contributions of response anonymity and structure of the omnibus survey to limiting of response biases. Conversely, weaknesses include the inability to substantiate participants' reports, to examine possible differences in dairy avoidance by race or ethnicity, or to quantify any possible sampling bias associated with interest in food or health. If these data are representative, they document symptom-related avoidance of wheat or dairy products by one in seven Australian adults of voting age. Not included in this estimate are those further adults (estimated at 5.8%) with symptom-unrelated explanations for their avoidance, other household members exposed to these dietary strategies, and children. Even if the survey figures should over-estimate prevalence, they testify to a significant public health phenomenon in the self-prescribed avoidance of dietary factors.

The self-prescribed nature of symptom-related dairy (and wheat) avoidance inevitably raises concerns about the rigour and accuracy of the diagnostic process and the risk of serious health conditions going undetected. A more serious issue arises if the elimination of a dietary factor is naively assumed to be intrinsically health enhancing without compensatory replacement of

sources of the missing nutrients. Irrespective of whether or not individuals are correct in identifying dairy products as the cause of their symptoms, we then have the paradoxical prospect of a health-motivated reduction in dairy consumption increasing risk of a condition like osteoporosis. Moreover, the volitional nature of a self-prescribed intervention lends it an added psychological potency. With a sense of autonomy come enhanced ownership of, adherence to, and consequently outcomes of, a health intervention [32; 33]. In the present case, this can be expected to increase also the likelihood of any adverse consequences.

Future directions

Clearly, these survey findings warrant follow-up investigation to determine both the decision processes leading symptomatic individuals to avoid dairy consumption and the impact on resultant nutritional status. Given the potential numbers of Australians involved, it is important to establish whether increased level of worry about illness is antecedent to or response to symptoms. The latter suggests that symptom severity may be a factor. Whether the attribution of symptoms to dairy is accurate is a matter for clinical investigation. However, the process is further complicated in the case of people who are also avoiding wheat products. Further questions for investigation include what other self-prescribed dietary changes consumers may be practicing, whether in response to symptoms or the perception that such behaviour is intrinsically health promoting. It is also noteworthy that few avoiders of dairy invoked lactose in explaining their behaviour. This cautions against the conclusion that the behaviour observed here substantially explains the market for lactose-free products; a similar point was made in respect of wheat avoidance and the gluten-free market [5]. Nor should the behaviour be interpreted as evidence of self-diagnosed food intolerances, which have been the topic of much discussion in recent decades [34; 35; 36]. A perceived intolerance is a particular attribution of a symptomatic

state and may thus represent the response of a subset only of those who avoid a dietary factor because of symptoms they associate with its consumption. It is the avoidance that especially demands systematic investigation.

Conclusions

In addition to the many adult Australians avoiding consumption of wheat or both wheat and dairy products, a similar further number reports avoiding dairy products, similarly mostly without a formal diagnosis, and citing largely similar, primarily gastrointestinal, symptoms. The accuracy of self-diagnoses, the actual sources of symptoms, and the physiological mechanisms remain to be established; in addition, the tendency for dairy avoidance to be associated with more worry about illness identifies both symptom severity and psychological responses to symptoms attributed to dairy as targets for further investigation. Most significantly, though, the findings are further evidence of a widespread tendency for people to seek to exercise control over their health by eliminating dietary factors considered suspect without medical evidence or oversight. Avoiding foods to alleviate adverse symptoms should be weighed against the consequences of eliminating dietary factors and their related nutrient profiles. In the case of dairy foods, those consequences could be significant for individuals and, given the apparent scale of the avoidance behaviour, for society in the long term.

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Contribution to the Paper	I was responsible for the design and implementation of the research project, including the collection of data. I performed all statistical analyses, interpreted the results, and wrote the manuscript, with input from all co-authors. I have acted as the corresponding author, since the manuscript's submission.	
Overall percentage (%)	80%	
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.	
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Co-Author Contributions

By signing the Statement of Authorship, each author certifies that:

   i.   the candidate's stated contribution to the publication is accurate (as detailed above);

   ii.   permission is granted for the candidate in include the publication in the thesis; and

   iii.   the sum of all co-author contributions is equal to 100% less the candidate's stated contribution.

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Chapter 4. Prevalence and psychological predictors of medically and non-medically diagnosed intolerance in Australia.

Abstract

Objective: Past research, mostly with clinical samples, has directed attention to psychogenic characteristics observed in patients with perceived food intolerance: in particular, anxiety, negative affect, and heightened vigilance for symptoms. The present study investigated (a) what predicts non-medically diagnosed (NMD) intolerances in the general population, and (b) whether predictors are peculiar to NMD or apply also to medically diagnosed (MD) intolerances.

Design: Cross-sectional population survey.

Setting: Conducted in Australia using a national omnibus survey.

Subjects: Adults aged 18 years and over (N = 938; 56.8% female) selected at random from the Australian Electoral Roll.

Results: Of 938 participants, 186 (19.8%) reported having one or more food allergies or intolerances. Almost seventy-four percent of people reporting intolerances (14.6% of sample) reported no medical diagnosis. Overall, reporting either a MD or a NMD intolerance was significantly predicted by somatosensory amplification tendency and a rejection of powerful others. Having MD intolerance was also predicted by need for cognition (negatively) and by an increased receptiveness to CAM. Having a NMD intolerance was significantly predicted by increased receptiveness to CAM.

Conclusions: Many adult Australians classify themselves as food intolerant without a supporting medical diagnosis. Null effects for neuroticism cast doubt on the role of anxiety and negative affect suggested by clinical research. The association of somatosensory amplification with both MD and NMD intolerances indicates that the tendency to be sensitised to and vigilant in respect of symptoms is not peculiar to the latter. Such vigilance may be an

unremarkable consequence of the belief that the ingestion of certain foods is likely to result in physical reactions.

Introduction

The experience of gastrointestinal, as well as other extra-abdominal complaints is frequently attributed to food hypersensitivity and intolerance. It has been reported that approximately one fifth of the general population in Western countries report symptoms related to food, and that many individuals believe that food allergy or intolerance is the underlying cause of their discomfort [1; 2; 3; 4; 5; 6]. A meta-analysis on the prevalence of food allergy [7] has concluded that the prevalence of perceived (i.e., self-reported) food hypersensitivity, based on short questionnaires, longer assessments, or interviews, is very high: up to 35% for any food. Despite these high self-report figures, the prevalence of food allergy, confirmed using the double-blind placebo-controlled food challenges (DBPCFC), the gold standard food intolerance diagnostic technique [8; 9; 10; 11] or medically by objective measures, has been reported as being much lower, ranging between 1% and 3% [3; 7; 12].

A review of the literature on adverse food reactions [2], revealed the difficulty in distinguishing between the different forms of adverse food reactions, reasons for symptoms often attributed to food allergy, food intolerance, irritable bowel syndrome, and other somatoform disorders. The review study describes the differences between food allergy (a classic immune-mediated reaction, where a protein is not recognised as safe by the immune system) and food intolerance (reactions that are non-immunological, having instead enzymatic, pharmacological or unknown causes), differences often not well understood by lay people. The review also referred to the possible involvement of psychological effects, which are thought of as either contributing to or determining the symptomology. The distinction between food allergy and food intolerance has further been complicated by commercial enterprises, which have marketed self-administered tests that "diagnose" food intolerance. These tests have claimed to measure the

presence of another type of antibody, IgG (Immunoglobulin G), in a pinprick of blood, which is different to the IgE (Immunoglobulin E) antibody, commonly understood to indicate an immunological reaction. It has been argued that this has confused and extended the definition of food intolerance by claiming an immunological origin of the symptoms [13; 14].

Recent literature, including the results of ten years of interdisciplinary research into food intolerance in clinical populations, has suggested that perceived food intolerance is a sensitisation disorder, not necessarily due to immunological mechanisms [15; 16; 17; 18; 19; 20; 21]. The studies conducted as part of this research have been of patients referred to the research hospital because of gastrointestinal complaints self-attributed to food intolerance. The investigations almost exclusively revolved around the possible contribution of psychogenic factors, such as anxiety, negative affect, and somatisation, to the pathogenesis of the patients' condition. More than half of the patients with perceived food intolerance were assessed as fulfilling the DSM-IV criteria of a psychiatric disorder, with depression (16%), generalised anxiety disorder (15%), panic disorder (13%), and somatoform disorders (12%) observed. Despite the fact that food allergy was rarely found in these patients, they were characterised as being continuously scanning the environment for offending agents, extra-vigilant with respect to their symptoms, constantly worried about their condition, and trying their best to avoid foods to which they attributed their problem [16]. Extra-vigilance to symptoms has been previously described as somatosensory amplification tendency and has been thought to result in a vicious cycle of misattribution and amplification of the symptoms [22]. It has been regarded as an important mechanism in the pathogenesis of functional somatic syndromes [23; 24].

Other clinical studies [25; 26; 27] have also reported an increased incidence of psychiatric disorder, depression, anxiety, worries, and somatisation amongst patients with perceived food intolerance. Pearson et al. [25] reported a high

incidence of anxiety, depression, and high suggestibility in patients, recruited from an allergy clinic, whose belief that they had a food allergy could not be confirmed. The patients with confirmed allergy had no psychological symptoms in the course of their reactions to food, unlike patients with perceived food intolerance, who were assessed as having some form of psychiatric disorder and attributed a wide range of physical and mental symptoms to food. The results of the study also showed that several patients became able to eat previously avoided foods after they modified their experience to external stress-provoking factors, were treated for depression, or had some therapy. This was thought to indicate that, in at least some patients, psychological factors were the cause rather than the result of food intolerance. Rix et al. [26] reported that genuine food allergy could not be confirmed in 19 of twenty-three patients who attributed common neurotic symptoms to allergy and that this group was almost identical, in terms of psychiatric symptomatology and general characteristics, to a group of new psychiatric out-patient referrals.

A few studies have examined psychological characteristics in perceived food intolerance in community samples. The findings of a study by Knibb et al. [28], with participants randomly recruited from districts of the Birmingham electorate, indicated that perceived food intolerance was associated with higher scores on neuroticism, compared to the rest of the sample. Women with perceived food intolerance scored significantly higher than control women on somatic symptoms, anxiety, insomnia, and severe depression, and neuroticism scores were higher in men with perceived food intolerance than in control men. The authors concluded that neuroticism might be a trait associated with perceived food intolerance in both genders, whereas somatic symptoms, anxiety, and depression may be associated with perceived food intolerance only in women.

Associations between perceived food intolerance and psychological distress were not confirmed by another community study of food intolerance [29]. Rather, the study findings demonstrated that most subjects reporting symptoms to food who were not judged to be allergic on clinical grounds did not manifest significant mood disturbance, impaired social adjustment, or other psychological symptoms. Peveler et al. found [29] that the subjects differed according to their principal causal attribution for symptoms, with patients who attributed their symptoms to food intolerance reporting a lesser degree of mood disturbance and impact of symptoms on everyday life, than those attributing symptoms to other gastrointestinal problems or stress.

With the exception of the studies of Peveler et al. [29] and Knibb et al. [28], the studies that have investigated and observed psychogenic and other characteristics of patients with perceived food intolerance, have included small samples of participants [25; 26; 30]and have been either limited to patients from allergy clinics [25; 26; 31], or to young college populations [27]. A more recent approach to the phenomenon of people attributing adverse symptoms to food were the Australian population studies of wheat avoidance [32] and dairy avoidance [33]. Also contrary to previous findings with mostly clinical populations, the studies found that, although avoidance of wheat or dairy products for the alleviation of physical symptoms occurred predominantly in the absence of formal medical diagnosis, they were not predicted by neuroticism or irrational or emotional reasoning styles. Wheat avoidance was associated with an increased receptiveness towards complementary and alternative medicine and a lesser receptiveness to conventional medicine; avoidance of dairy but not wheat was, however, predicted by worry about illness [32; 33].

The findings from these population studies broadly suggest two questions for investigation. First, they suggest that the behaviour of food avoidance as a health-related practice may well be related to more prosaic, non-

psychogenic individual-level characteristics that predispose certain individuals to attribute distressing symptoms to the consumption of certain food items or components and, without supporting evidence from expert diagnosticians, to subsequently label themselves as food intolerant. For example, the decision to avoid wheat appeared to be influenced substantially by information from non-medical sources, and was predicted by increased receptiveness to complementary medicine and lesser receptiveness to conventional medicine [32]. Psychological characteristics not examined, such as health locus of control or the personality trait conscientiousness could be potentially important, as they have been shown by other research to play an important role in health-related processes by influencing health behaviours [34]. Conscientiousness has been identified as the most important predictor of health [35; 36], and as a significant factor in the health-related practices in which individuals engage. The notion of locus of control has been utilised in predicting health-enhancing behaviours, and in particular in investigation of the relationship between various health practices and individuals' expectancies about control over their health [37]. Underlying these possibilities is also the question whether the psychological characteristics associated with perceived food intolerance in mostly smaller clinical studies can be generalised to people with perceived food intolerance in the general population.

Secondly, the differential findings for illness worry provide a reminder that symptom-related psychological distress may be a response rather than antecedent to symptoms. That prompts the question whether a phenomenon like somatosensory amplification is peculiar to non-medically diagnosed food intolerances or also observed in cases of medically diagnosed food intolerance.

We report an Australian population survey examining reported food intolerances, associated symptoms, the sources of diagnosis, and the

psychological predictors of reporting of medically diagnosed (MD) and non-medically diagnosed (NMD) intolerances. The psychological predictors comprised somatosensory amplification tendency, the personality characteristics neuroticism and conscientiousness, health locus of control, rational and emotional reasoning styles, receptiveness to complementary medicine, and receptiveness to conventional medicine.

Method

Participants and study design

Data for this study were obtained from a cross-sectional survey of attitudes and behaviours related to health, diet, foods, and food characteristics in an adult Australian population sample selected at random from the Australian Electoral Roll. The data were collected through the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) 2013-14 Food and Health Survey. Survey forms were posted to a proportional stratified random sample of eligible voters (aged 18 years and over), which was selected from the eight States and Territories of Australia by the Australian Electoral Commission. Nine hundred and thirty eight of a possible 2873 completed questionnaires were returned (a response rate of 32.6%).

The sample consisted of adults aged 18 years and over: 358 males (38.2%), 533 females (56.8%) and forty-seven not specified (5.0%); mean reported age was 54.13 (SD 16.87) years. The data were weighted to adjust for gender and age over-representation relative to the population in the calculation of population prevalence estimates.

Procedure

The CSIRO Food and Health Survey was conducted between December 2013 and February 2014 and assessed attitudes and behaviours in response to health, foods, and food characteristics. In particular, it asked questions about

allergies or intolerances, sources of diagnoses and symptoms associated with these intolerances, and psychological characteristics. A letter informing the potential respondents of the survey was mailed out a week before the survey forms. Survey packages included a CSIRO-labelled ballpoint pen and a reply-paid envelope. A follow-up letter thanking respondents and reminding people who had yet to respond was sent two weeks after the distribution of the survey forms. The study was designed according to the guidelines laid down in the Declaration of Helsinki, and ethics approval was obtained from the CSIRO Human Research Ethics Committee.

Variables

A section of the survey, labelled 'Food allergies, intolerances and sensitivities', was the main focus of this study. It asked participants to identify whether or not they had an allergy or intolerance to any food or food ingredient. Those who answered in the affirmative were asked to indicate for ten listed foods or food components: (i) whether they had an allergy or an intolerance, (ii) the source of diagnosis, whether it was a medically diagnosed, diagnosed by a complementary or alternative medicine (CAM) practitioner, or not formally diagnosed, and (iii) the reactions or symptoms they attributed to that allergy or intolerance. Provision was made for participants to add details in respect of foods not listed, however this section usually returned uncompleted.

Participants also completed the following individual-difference measures:

Health locus of control was assessed by Multidimensional Health locus of Control (MHLOC) scale. Originally developed by Wallston et al. [37] the MHLOC measures beliefs with respect to health along three dimensions: the extent to which individuals believe their health to be the result of their own actions (internal), powerful others, and chance. The shortened (9-item) version consists of three items for each of the three proposed dimensions of

health control and was scored using a six-point Likert format [38]. Each of the three dimensions was assessed by three statements regarding the relevant health beliefs (e.g. 'No matter what I do, if I am going to get sick, I will get sick', 'My good health is largely a matter of good fortune', 'The main thing which affects my health is what I do myself'). For each dimension the sum of items is calculated. A high score indicates a high importance of the locus of control in the given dimension.

The Somatosensory Amplification Scale (SSAS) [22] is a 10-item self-report scale, validated to assess the tendency to experience somatic and visceral bodily sensations as intense, noxious, and disturbing. Somatosensory amplification involves sustained self-examination and increased attention and vigilance to unpleasant somatic sensations, a predisposition to observe the weakest and rarest of somatic sensations, and a tendency to interpret them as dangerous signs of disease without any rational argument [39]. Participants rated ten statements (e.g. 'I am often aware of various things happening in my body', 'When I bruise myself, it stays noticeable for a long time') on a five-point scale, where 1='not at all true' and 5='extremely true'.

The ten-item version of the Rational-Experiential Inventory (REI) [40] consists of five-items from the Need for Cognition Scale [41] and five items from the Faith in Intuition Scale [40]. Each item was rated on a five-point scale, ranging from 'completely false' to 'completely true', higher subscale scores representing increased reliance on analytical and intuitive thinking, respectively.

Ten-item IPIP (International Personality Item Pool) scales [42] were used to measure Neuroticism – the tendency to experience negative emotions, such as anger, anxiety, depression and vulnerability to stress – and Conscientiousness – the tendency to show self-discipline, act dutifully, and aim for achievement – respectively. Participants rated ten statements for

each scale (Neuroticism e.g. 'I often feel blue', I have frequent mood swings', Conscientiousness 'I am always prepared, 'I get chores done right away') on a five-point scale, where 1 = 'very inaccurate' and 5='very accurate'. Higher scores on neuroticism represent increased emotionally reactivity and vulnerability to stress. Higher scores on conscientiousness indicate a preference for planned rather than spontaneous behaviour.

A section labelled General Health asked participants to rate their general health on a five-point scale from 1='poor' to 5='excellent' and to indicate whether they had ever been diagnosed with any of the following conditions: Irritable Bowel Syndrome, Inflammatory Bowel Disease, Chronic Fatigue Syndrome, Asthma, and Depression. The section also asked participants to rate from 1='definitely not' to 7='definitely', their likelihood of taking each of nine actions (e.g., consult a doctor, consult a naturopath) for a serious health matter. These questions comprised scores on two subscales, 'Complementary treatments scale' (five items) and 'Conventional treatments scale' (four items) [32]. A section labelled 'Demographic information' asked participants to indicate their sex, age, postcode, and level of education.

Statistical analyses

Prior to analyses, the pattern of missing data for the continuous variables was investigated. Tests for non-normality and univariate and multivariate outliers were conducted to ensure suitability of the data for analysis and interpretation. Analyses were summary statistics for descriptive purposes, logistic regression for prediction and one-way ANOVA with post-hoc comparisons using the Tukey HSD test. A particular purpose of the study was to identify categories of a given behaviour (e.g., subtypes of individuals with food intolerance) and the individual-difference and behavioural predictors of membership of each category. Descriptive statistics of the data reported in Figure 1 were weighted by demographic criteria as necessary, to represent

their distribution in the Australian community. The statistical software package IBM SPSS Statistics 22 was used for all analyses.

Results

Of all 938 participants who completed the questionnaires, 186 (19.8%; 20.5% weighted) reported having one or more food allergies or intolerances /sensitivities (Fig.1). It was apparent from responses that participants did not always use the term "allergy" appropriately as denoting an immune system response; henceforth, the term "intolerances" will be used here to represent reported allergies as well as intolerances / sensitivities.

Of the total number of people reporting intolerances, 137 (73.7%) people reported one or more non-medically diagnosed (NMD) intolerances: namely, intolerances that were either complementary-and-alternative medicine (CAM) diagnosed or not formally diagnosed. Included in this number were 37 (19.9%) people who reported both non-medically diagnosed intolerances and one or more (different) medically diagnosed (MD) intolerances. Forty-nine participants (26.3%) reported only MD intolerances.

Fig. 1 Flowchart showing prevalence of reported medically diagnosed and non-medically diagnosed food allergies/intolerances
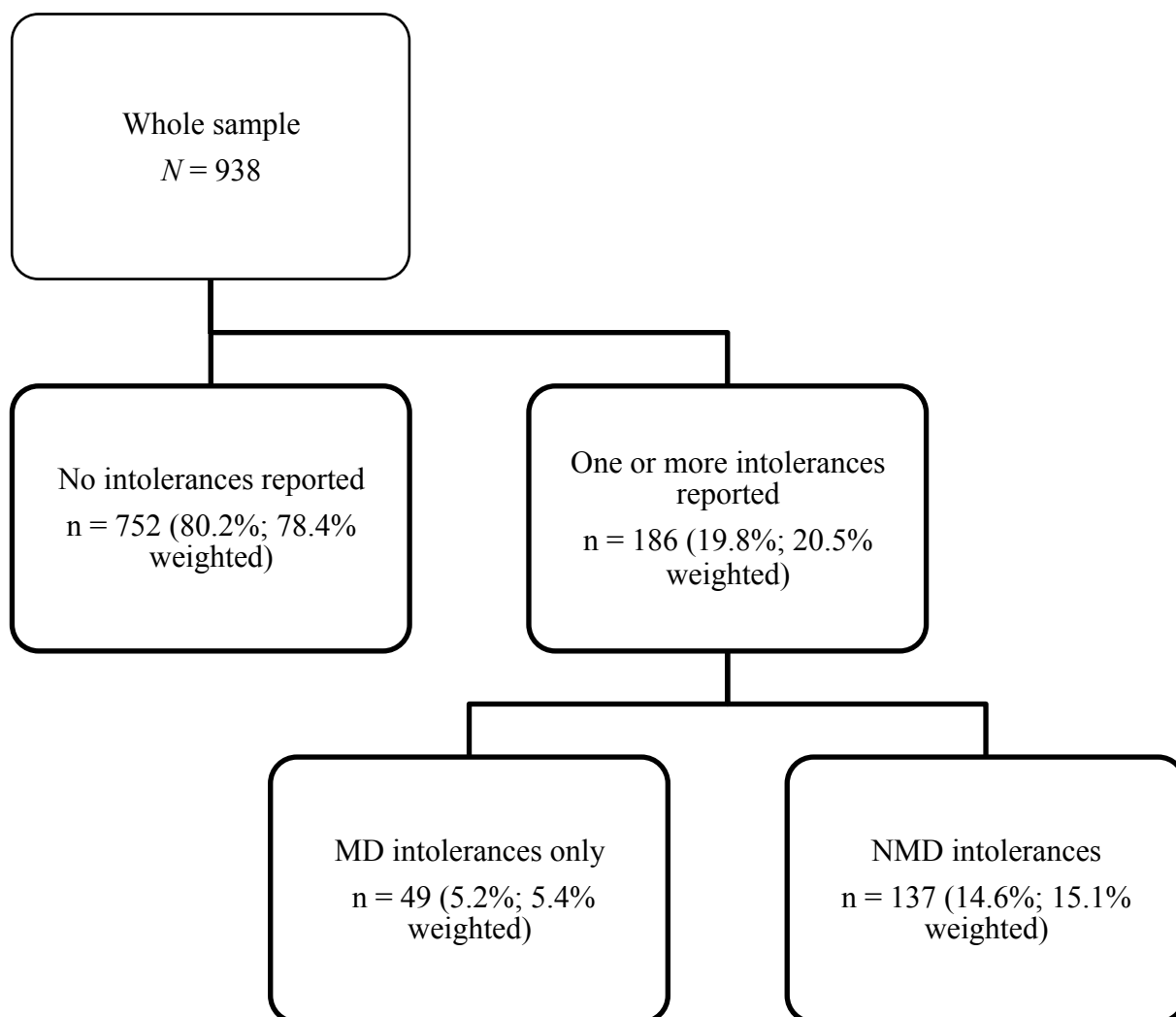

Table 1 lists the frequency of occurrence of medically, CAM and non-formally diagnosed intolerances. It also lists the total non-medically diagnosed intolerances to these food substances, calculated as the sum of CAM diagnosed and non-formally diagnosed allergies or intolerances. The most

frequently reported intolerances were to lactose, gluten, wheat, dairy, and food additives.

Table 1 Reported intolerances by diagnosis: medically diagnosed (MD), complementary or alternative medicine practitioner diagnosed (CAM), non-formally diagnosed (NFD), and combined non-medically diagnosed (NMD).

Food or food components	MD		CAM		NFD		NMD		Total	Total	% of NMD
	N	%	N	%	N	%	N	%	N	%	%
Lactose	28	3.0	10	1.1	42	4.5	52	5.5	80	8.5	65.0
Gluten	28	3.0	13	1.4	33	3.5	46	4.9	74	7.9	62.1
Wheat	20	2.1	12	1.3	23	2.5	35	3.7	55	5.9	63.6
Dairy	15	1.6	13	1.4	19	2.0	32	3.4	47	5.0	68.1
Food Additives	8	0.9	4	0.4	29	3.1	33	3.5	41	4.4	80.5
Egg	11	1.2	5	0.5	21	2.2	26	2.8	37	3.9	70.3
Fish	9	1.0	2	0.2	21	2.2	23	2.5	32	3.4	71.9
Nuts	8	0.9	7	0.7	12	1.3	19	2.0	27	2.9	70.4
Fructose	6	0.6	3	0.3	12	1.3	15	1.6	21	2.2	71.4
Soy	5	0.5	1	0.1	14	1.5	15	1.6	20	2.1	75.0
Total	138		70		226		296		434		

Note: Multiple responses were allowed

Table 2 reports the main symptoms attributed by participants to medically and non-medically diagnosed intolerances. The most commonly reported reactions were gastrointestinal problems.

Table 2 Frequency and type of symptoms reported in respect of medically diagnosed (MD) and non-medically diagnosed (NMD) intolerances

Symptoms	MD *n*	% of total MD	NMD *n*	% of total NMD
Gastrointestinal problems	57	29.5	240	38.0
Inflammation or swelling	20	10.4	80	12.7
Fatigue	26	13.5	69	11.0
Skin problems	13	6.7	60	9.5
Body aches and pains	34	17.6	54	8.5
Breathing problems	17	8.8	46	7.3
Mood (e.g., irritability, depression)	17	8.8	43	6.8
Food cravings	7	3.6	20	3.2
Behaviour (e.g., hyperactivity)	2	1.0	20	3.2
Total	193		632	

Note: Multiple responses were allowed

Table 3 shows the results of a multivariate logistic regression of individual differences associated with the reporting of any medically diagnosed and non-medically diagnosed intolerance. The psychological predictors included in the model (selected on the basis of the findings in the literature review discussed in the in the introduction of this paper) comprised somatosensory amplification tendency, the personality characteristics neuroticism and conscientiousness, health locus of control, rational and emotional reasoning styles, receptiveness to complementary medicine, and receptiveness to conventional medicine.

Participants who reported both MD and NMD intolerances were included in the NMD category only. Compared to the rest of the sample, reporting of medically diagnosed-only intolerances and reporting of non-medically

diagnosed intolerances were both significantly predicted by somatosensory amplification tendency and powerful others health locus of control (negatively). Reporting MD-only intolerance was also predicted by analytical thinking style (negatively) and by increased receptiveness to conventional medicine; reporting NMD intolerance was significantly predicted by increased receptiveness to complementary and alternative medicine. No significant effects were found in case for the predictors Neuroticism, Conscientiousness, Intuitive thinking, Chance Health Locus of Control, Internal Health Locus of Control, or Gender.

Table 3 Multivariable logistic regression of predictors of reporting medically diagnosed (MD) and non-medically diagnosed (NMD) allergies/intolerances.

Medically diagnosed allergies/intolerances							
						95% CI for OR	
Independent Variables/Predictors	B	se	Wald	Sig.	Exp(B)	Lower	Upper
Somatosensory Amplification Tendency	.906	.267	11.484	.001**	2.474	1.465	4.177
Health Locus of Control - Internal	-.162	.172	.888	.346	.850	.607	1.191
Health Locus of Control - Chance	-.275	.146	3.537	.060	.759	.570	1.012
Health Locus of Control – Powerful Others	-.273	.129	4.525	.033*	.761	.591	.979
Faith in Intuition (Intuitive thinking style)	.148	.232	.409	.523	1.160	.736	1.829
Need for cognition (Analytical thinking style)	-.536	.254	4.462	.035*	.585	.356	.962
Neuroticism	-.285	.269	1.125	.289	.752	.444	1.273
Conscientiousness	.476	.286	2.773	.096	1.609	.919	2.816
Receptiveness to complementary and alternative medicine	.272	.145	3.499	.061	1.312	.987	1.744
Receptiveness to conventional medicine	.510	.233	4.768	.029*	1.665	1.054	2.630
Sex (male)	-.402	.365	1.208	.272	.669	.327	1.370

Non-medically diagnosed allergies/intolerances only

						95% CI for OR	
Independent Variables/Predictors	B	se	Wald	Sig.	Exp(B)	Lower	Upper
Somatosensory Amplification Tendency	.498	.173	8.242	.004**	1.642	1.170	2.302
Health Locus of Control - Internal	-.129	.111	1.339	.247	.879	.707	1.093
Health Locus of Control - Chance	-.132	.091	2.107	.147	.876	.733	1.047
Health Locus of Control – Powerful Others	-.183	.085	4.603	.032*	.833	.705	.984
Faith in Intuition (Intuitive thinking style)	.097	.143	.460	.498	1.102	.833	1.458
Need for cognition (Analytical thinking style)	.242	.157	2.375	.123	1.274	.936	1.734
Neuroticism	.222	.164	1.840	.175	1.249	.906	1.721
Conscientiousness	.111	.182	.375	.540	1.118	.783	1.597
Receptiveness to complementary and alternative medicine	.313	.093	11.286	.001**	1.368	1.139	1.642
Receptiveness to conventional medicine	-.089	.127	.495	.482	.914	.713	1.173
Sex (male)	-.311	.222	1.962	.161	.732	.474	1.132

Model χ^2 = 85.52, p < .0.001, Pseudo R = .092 (Cox & Snell)

n = 938

A follow-up one-way ANOVA was conducted to compare the scores on Somatosensory Amplification Tendency in the three groups: MD, NMD, and Rest of the Sample. There was a statistically significant effect of group membership (F = 10.434; p < .001). Post-hoc comparisons using the Tukey HSD test indicated that the mean somatosensory amplification tendency scores for MD (M = 2.83; SD = .73) and NMD (M = 2.66; SD = .61) groups were significantly higher than for the rest of the sample (M = 2.48; SD = .63), p < .05 but did not differ significantly from each other.

Discussion

This study addressed the prevalence and psychological predictors of both non-medically diagnosed and medically diagnosed food intolerances in an Australian population sample. The findings suggest that a significant proportion of adult Australians classify themselves as food intolerant without a supporting medical diagnosis. Almost one in five participants reported having an allergy or intolerance to at least one food. Approximately three quarters of people reporting intolerances, amounting to 14.6% of the sample, reported non-medically diagnosed intolerances: intolerances that were either CAM diagnosed, or otherwise not formally diagnosed. The most commonly reported non-medically diagnosed intolerances were to gluten, wheat, lactose, dairy, and food additives. Reported symptoms showed a far higher prevalence of gastrointestinal than any other symptoms.

Reporting a medically diagnosed intolerance was associated with a less analytical thinking style and greater receptiveness to conventional medicine, whereas reporting a non-medically diagnosed intolerance was predicted by greater receptiveness to complementary and alternative medicine. Otherwise, the tendency to report an intolerance – whether medically diagnosed or non-medically diagnosed – was significantly predicted by somatosensory amplification tendency and health locus of control involving a relative rejection of powerful others, which is usually understood to mean doctors and other medical specialists.

These findings raise several points for discussion. First, null effects for neuroticism for non-medically (as for medically) diagnosed intolerances are inconsistent with the central role of anxiety and negative affect suggested by previous studies, which were mostly of clinical samples. These studies associated perceived food intolerance with psychogenic factors, which were proposed to contribute to somatization mechanisms of heightened

perception and misattribution of bodily symptoms [15; 16; 25]. A second challenge to this line of argument is posed by the finding that somatosensory amplification predicted reporting of medically diagnosed as well as of non-medically diagnosed intolerances. This finding raises the possibility that somatosensory amplification, in appearing to be associated with the understanding that one has a food intolerance (medically supported as well as unsupported) is an unremarkable consequence of the belief that the ingestion of certain foods results in particular physical reactions, rather than a cause of the condition and its symptoms.

The association between reporting of non-medically diagnosed intolerance and receptiveness towards complementary and alternative medicine points to the potential role of social factors in perceived intolerances. The tendency of individuals to attribute distressing symptoms to the consumption of certain foods or food components without supporting evidence from medical diagnosticians may reflect a shift in the doctor-patient relationship towards alternative therapies and challenging of doctors' authority [43; 44]. Such a shift may also involve a trend towards self-diagnosis and management of symptoms as individuals seek to exercise control over their health [45].

Clinical implications and future directions

Our findings, if representative of the population at large, suggest that one fifth of adult Australians have experienced adverse symptoms that they associate with specific foods to which they classify themselves as intolerant. This research is important as these behavioural trends have serious implications for the individual, as well as public health in general. Irrespective of whether or not individuals are correct in identifying the sources as the cause of their symptoms, the prospect of eliminating foods or food components because of perceived food intolerance is concerning. A risk amongst those who self-diagnose is that the misinterpretation of symptoms

when not diagnosed by a medically trained practitioner may lead to unnecessarily restrictive diets, malnourishment, or eating disorders [2].

A direction for future research is suggested by the finding that somatosensory amplification predicted reporting of medically diagnosed as well as of non-medically diagnosed intolerances. Previous clinical research has identified somatisation in perceived food intolerance as a possible manifestation of processes postulated to explain severe symptoms in functional somatic syndromes. Somatosensory amplification, through the role of stress and anxiety, has been suggested to play an important role in the psychopathological mechanism of functional somatic syndromes [23]. It is thought to exacerbate and perpetuate physical symptoms and make people quicker to conclude that an ambiguous bodily sensation is due to disease [24].

A challenge, therefore, for future research is to establish to what degree the somatosensory amplification observed in medically and non-medically diagnosed food intolerance is a response to the experiencing of severe symptoms rather than a predisposing antecedent to a presumed intolerance. This also identifies, as a next step for investigation, the need to explore possible somatisation mechanisms behind reported severe reactions to symptoms in perceived food intolerance. A way of approaching this would be to investigate characteristics, including severity of symptoms, somatosensory amplification, illness perception and illness behaviour specifically in the context of a functional somatic syndrome, such as IBS, where for its pathogenesis they have been regarded as important. In particular, psychosomatic manifestations of IBS such as visceral hypersensitivity and somatosensory amplification are regarded as predecessors of symptoms, high in frequency and severity.

It should also be noted that perceived food intolerance is a particular attribution for a perceived adverse reaction to a food, and this process of

attribution warrants research interest, including comparisons with symptomatic food avoiders who do not invoke the notion of intolerance. Finally, indications that the high prevalence of self-diagnosed food intolerance in the general population may not be the result of atypical psychopathology emphasise the need for further investigation of the role of other non-psychogenic factors in perceived food intolerance, such as health locus of control and the influence of complementary and alternative medicine, as there is a clear indication of their association.

Several limitations of this study should be noted. First, like other studies of perceived intolerance, it relies on correlational data and therefore supports no causal conclusions. Secondly, in a general population sample, there is no way of knowing how many participants self-diagnosed themselves incorrectly, or potentially got their diagnosis right. It is possible that some of these participants may have self-diagnosed themselves correctly, but have never consulted with a health care practitioner. Therefore, the mechanisms involved and characteristics of individuals who misattribute their symptoms to food could potentially be different from those who have self-diagnosed correctly. Thirdly, even claims of medical diagnoses could not be confirmed, and there was no information requested from the participants on whether they were diagnosed by a formal allergy blood test, other medical tests, or by way of a doctor's recommendation. This need not seriously undermine the interpretation of these reports of medical diagnosis as representing participants' beliefs, however. For present purposes, it is the perceived licence to claim a medical diagnosis, however tenuously founded that differentiates these perceived intolerances conceptually from those for which no medical validation can be claimed.

Conclusions

Our findings suggest that a significant proportion of adult Australians classify themselves as food intolerant without a supporting medical diagnosis. However, the observed association of somatosensory amplification with both medically and non-medically diagnosed food intolerance casts doubt on the presumed role of somatosensory amplification in the cause, maintenance, and exacerbation of symptoms of perceived (as opposed to actual) intolerance. Rather, it raises the possibility that vigilance and heightened sensitivity to somatic sensations are responses to the understanding – well founded or not – that the ingestion of certain foods is prone to trigger particular physical reactions. This challenges the presumption that the high prevalence of self-diagnosed food intolerance in the general population is the result of atypical psychopathology. It does not preclude the possibility that such vigilance and sensitivity may help maintain and exacerbate the experience of symptoms, but again suggests that such an effect will not be peculiar to intolerances for which patients lack the reassurance of medical validation.

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Contribution to the Paper	I was responsible for the design and implementation of the research project, including the collection of data. I performed all statistical analyses, interpreted the results, and wrote the manuscript, with input from all co-authors.
Overall percentage (%)	80%
Certification:	This paper reports on original research I conducted during the period of my Higher Degree by Research candidature and is not subject to any obligations or contractual agreements with a third party that would constrain its inclusion in this thesis. I am the primary author of this paper.
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Chapter 5. IBS and food intolerance: differences in somatic symptom severity, somatosensory amplification and illness perception.

Abstract

Objective: Past research has directed attention to a potentially important role of the tendency to be vigilant in respect of symptoms and to experience symptoms as more intense, noxious, and disturbing in the perception and maintenance of food intolerance. It has also frequently identified overlap in symptoms between IBS and food intolerance, high prevalence of perceived food intolerance among subjects with IBS and severe symptoms in both perceived food intolerance and IBS. This raises the question of whether food intolerance may represent another manifestation of the same psychosomatic processes associated with functional somatic syndromes, such as IBS, in particular with respect to somatosensory amplification tendency, illness perception and illness behaviour. The present study explores these as potential mechanisms behind severe reactions to symptoms in food intolerance.

Methods:

Cross-sectional survey; Adults aged 18 and over reporting food intolerance and/or IBS, recruited from general practice (GP) and allergy and food intolerance clinics. The measures used in the study included The Brief Illness Perception Questionnaire (BIPQ), Somatic Symptom Severity Scale (PHQ-15), The Symptom Response Questionnaire, Somatosensory Amplification Scale, The Hospital Anxiety and Depression Scale (HADS), The Multidimensional Health Locus of Control Scale (MHLC), Complementary Treatments Scale and Conventional Treatments Scale.

Results: Of the 50 patients, 29 (58%) reported having IBS, of whom 15 (30%) also reported having IBS+FI. A further twenty-one people (42%) reported FI, but not IBS.

One-way ANOVAs with planned comparisons were conducted to compare the responses by the IBS only, IBS + FI, and FI only groups on: PHQ-15, SSAS, anxiety and depression. Results showed statistically significant group differences in symptom severity (F = 12.52, p < .001) and somatosensory amplification (F = 3.28, p < .05) with significant difference between the FI group and the other IBS and IBS+FI groups in each case: PHQ-15, (p < .001; SSAS, p < .05). Symptoms appeared to be reported less frequently by the FI group compared to the IBS+FI group and the IBS group. There was a statistically significant difference (t = -2.57, p < .05) between the illness perception of FI (M=5.73, SD=1.26) and that of IBS (M=6.22, SD=1.20), where the higher mean score for IBS reflects a more threatening view of the illness.
Conclusions: In this study we have found a lower reported number of severe symptoms and a weaker tendency to amplify and attribute them to a threatening disease in patients reporting food intolerance, compared to those reporting IBS, with or without food intolerance. The findings support the view that the experiencing of and anxiety about severe, disturbing symptoms accompany a presumed diagnosis of IBS and are not peculiar to the perception that one has a food intolerance.

Key words: Food intolerance; Irritable bowel syndrome; Functional somatic syndrome; Somatosensory amplification tendency; Severity of symptoms; Illness perception;
Acronyms: FI = Food allergy or intolerance; FI+IBS = Food allergy or intolerance and irritable bowel syndrome; IBS = Irritable bowel syndrome; SSAS = Somatosensory Amplification Scale;

Introduction

Food sensitivity and intolerance has been associated with distressing symptoms, both gastrointestinal (bloating, stomach pain, diarrhoea, constipation) and extra-abdominal (back pain, fatigue, stiff joint and headache) [1]. A few studies have noted that most of these symptoms overlap with the symptoms of irritable bowel syndrome (IBS), a disorder of the class of functional somatic syndromes [2]. The symptoms of IBS also range from gastrointestinal symptoms to medically unexplained extra-intestinal symptoms, (somatic complaints), such as headache, back pain, fatigue, poor sleep, shortness of breath, muscle or joint aches or pain [3; 4]. The observed overlap in symptoms makes it no surprise that a high rate of food intolerance has been often reported among subjects with IBS (up to 84%) [5; 6; 7; 8].

Overlap between somatic symptoms has already prompted some researchers to argue that the existence of specific functional somatic syndromes (unexplained, persisting symptoms for which no objective or observable abnormalities have been found) could be interpreted as an artefact of medical specialisation [9]. They have proposed that this differentiation is due to the tendency of medical practitioners to focus on and describe a common set of symptoms according to their discipline – e.g. gastroenterologists on IBS, rheumatologists on chronic joint pain, allergy specialists on food intolerance, infectious-disease specialists on chronic fatigue. This raises the question of whether the characteristics of food intolerance may also represent another manifestation of the same physiological or psychosomatic processes associated with gastrointestinal functional somatic syndromes, such as IBS.

Frequently identified by research characteristics of IBS patients include persistent somatisation, high dissatisfaction with health, low pain threshold

and somatosensory amplification (defined as heightened vigilance to and misattribution of bodily symptoms) [10], all leading to symptoms, high in frequency and severity, [3; 4; 11]. Studies of IBS sufferers have indicated that visceral hypersensitivity [11] is a common trait in these patients [12; 13]. A review study of the published literature on IBS has indicated that psychological disturbances are common in IBS patients, especially those who seek treatment [14]. The study found that of the IBS patients, 50% to 90%, had psychiatric disorders, including panic disorder, generalized anxiety disorder, social phobia, posttraumatic stress disorder, and major depression [14].

Some evidence has suggested an increased perception of vulnerability to illness, including non-gastrointestinal illness, in individuals with IBS [15], which has been thought to contribute to IBS-related illness behaviour and symptom maintenance. Hobbis, Turpin and Read, [16] have also investigated health locus of control and illness behaviour in IBS patients, as potential evidence of underlying psychological distress and as influencing health-care-seeking behaviour. That study has indicated that IBS patients differed significantly on illness behaviour and health locus of control from the group of non-patients, with IBS patients showing higher levels of abnormal illness behaviour. However, a greater association was also found between abnormal illness behaviour and psychopathology in general, irrespective of group membership, which suggested that illness behaviour might be related to psychological distress, irrespective of patient status.

Perceived food intolerance (the belief that symptoms are due to an intolerance or sensitivity to certain foods, in the absence of formal medical diagnosis [18]) has also been associated with psychogenic factors [17; 18; 19; 20; 21; 22; 23; 24], in particular, anxiety, negative affect and somatosensory amplification tendency. The concept of somatosensory amplification tendency has been described as being equivalent to that of visceral

hypersensitivity [11], often found in IBS patients [12; 13]. However, these associations between perceived food intolerance and psychological distress reported in studies of patients who attended specialist allergy clinics were not confirmed by the results of a larger community study of food intolerance [25]. The study found that their participants differed according to how they attributed the principal cause for their symptoms. Those who attributed their symptoms to food intolerance reported a lesser degree of mood disturbance and impact of symptoms on everyday life than the participants who attributed symptoms to other gastrointestinal problems or stress. Those who attributed their symptoms to food intolerance also reported relatively low levels of psychological disturbance and were also less likely to consult general practitioners and other medical specialists, compared to that seen in the general population.

Also contrary to previous findings with clinical populations, a recent Australian population survey found that, although avoidance of wheat or dairy products for the alleviation of physical symptoms occurred predominantly in the absence of formal medical diagnosis, they were not predicted by neuroticism or an illogical reasoning style; avoidance of dairy but not wheat was, however, predicted by worry about illness [26; 27]. Subsequent findings with an Australian population sample (Yantcheva, Golley, & Mohr, submitted for publication) indicated that reporting a food intolerance – whether with or without a supporting medical diagnosis – was predicted by greater somatosensory amplification tendency compared to the rest of the population. The cross-sectional nature of the study does not indicate the direction of causation in the association between somatosensory amplification and food intolerance (both medically diagnosed and non-medically diagnosed) and this association therefore requires further exploration. However, this result also raises the possibility that somatosensory amplification, which appears to be associated with the understanding that one has a food intolerance (medically supported as well

as unsupported) may be a consequence rather than a cause of the condition and its symptoms.

The findings with general population samples thus cast doubt on the central role of anxiety and negative affect in perceived food intolerance suggested by clinical studies [17; 18; 19; 20; 21; 22; 23; 24]). In particular, they indicate that the somatosensory amplification or the tendency to be sensitised to and vigilant in respect of symptoms and to experience bodily sensations as more intense, noxious, and disturbing may be a predictable consequence of the belief that the ingestion of certain foods triggers certain physical reactions, whether or not this belief has been medically endorsed. This possibility also identifies the need to explore the mechanisms behind severe reactions to symptoms in perceived food intolerance as a next step for investigation.

The overlap in symptoms between IBS and food intolerance, together with the high prevalence of perceived food intolerance among subjects with IBS and the severity of symptoms frequently identified in IBS patients, raise the possibility that severe and amplified reactions, often associated with food intolerance in previous research may not be peculiar to the perception that one has a food intolerance, but may instead be responses to the presence of IBS - a psychosomatic disorder and IBS-like symptoms.

This possibility raises the need for the present study, which aims to provide a better understanding of how somatisation mechanisms, including severity of symptoms, extra-vigilance and amplification of symptoms, illness perception and illness behaviour, observed in IBS and usually manifested in a psychosomatic condition, compare to those reported in food intolerance. The possibility that these somatisation mechanisms may not be due to the perception that one has food intolerance results in formulating the hypothesis that patients reporting food intolerance would differ from IBS patients and patients with both IBS and food intolerance in (a) symptom

severity, (b) somatosensory amplification tendency, as a measure of extra-vigilance, (c) perception of severity of illness, and (d) illness behaviour. The study also explored whether there were any significant differences between the patients on other psychological features, including health locus of control, anxiety and depression, receptiveness to complementary and alternative medicine and receptiveness to conventional medicine.

Method

Participants and study design

Data for this study were obtained by cross-sectional survey of the psychological and demographic characteristics of adult patients reporting food intolerance and/or IBS.

The recruitment of participants was from general medical practices (GP), as well as from allergy and food intolerance clinics. The sample consisted of adults, aged 18 years and over: 14 IBS patients, 21 patients with food intolerance and 15 patients who reported having both food intolerance and IBS. Of the 50 participants, 44 were female. Ethics approval for this study was obtained from the Human Research Ethics Committee of the University of Adelaide.

Procedure

The researchers contacted the GP and allergy clinics and asked for assistance with distributing the questionnaires. The questionnaires were left at the clinics, available to all patients who wished to participate. The researchers collected the completed questionnaires. The participants received an information sheet, attached to the questionnaire, which informed them of the voluntary and anonymous nature of the research, their right to withdraw at any time, and that their involvement in the study had no bearing at all on their practitioner-patient relationship.

Instruments

The questionnaire contained separate sections labelled 'Food Allergies and Sensitivities' and 'Irritable Bowel Syndrome', where participants were asked to identify if they had each condition and who diagnosed it. The distinction between allergy and intolerance appeared to be misunderstood by some participants, as indicated by a small number of reported allergies, none of which was attributed to a medical diagnosis. The food intolerance and IBS sections also each contained the Brief Illness Perception Questionnaire (BIPQ) [28], a scale measuring patients' cognitive and emotional representations of the condition in question including consequences, timeline, personal control, treatment control, identity, coherence, concern, emotional response, and causes. The responses to the questions represent the degree to which an illness is perceived as threatening or benign, a higher score reflecting a more threatening view of the illness. The Brief IPQ has been shown to have good test–retest reliability and predictive validity [28].

Responses to additional sections on chronic fatigue syndrome and asthma were not used in the present analysis. A section labelled 'Your Health', asked questions about participants' general health, including whether participants had ever been diagnosed with inflammatory bowel disease, anxiety disorder, coeliac disease or depression. The remaining measures did not specify any condition.

Somatic Symptom Severity Scale (PHQ15) [29]. The PHQ-15 is a brief, self-administered questionnaire that measures the severity of somatic symptoms. It comprises of 15 somatic symptoms, which include 14 of the most prevalent DSM-IV somatization disorder somatic symptoms (those with a prevalence of 3% or greater in the general population) [30]. In determining the PHQ-15 score, each symptom is scored from 0 ('not bothered at all') to 2 ('bothered a lot'), and the total score ranges from 0 to 30. The PHQ-15 has

shown high internal reliability, convergent validity and discriminant validity [29].

The Symptom Response Questionnaire [31] is an instrument developed to assess, in a structured manner, an individual's illness behaviour in response to 13 common illness or pain symptoms. This measure describes each symptom in terms of duration and/or intensity and asks the individual to check as many responses, as he or she is likely to employ in handling the problem. Early pilot work with the measure has indicated that more than one response to each symptom was the norm rather than the exception. The categories of response sets have been grouped into the factors, labelled 'Self Help' (decrease social activities, increase bed rest, eat special foods, decrease work, take over the counter medication); 'Professional Help' (see MD, take prescription drugs, visit the ER); 'Ignore', and 'Think and Talk' or 'Obsess' without necessarily taking action (think about the cause, talk to co-workers about this symptom).

A section, labelled 'Personal Characteristics' contained the following measures: the Somatosensory Amplification Scale [32], the Hospital Anxiety and Depression Scale [33], the Multidimensional Health Locus of Control Scale (MHLC) [34], and the 'Complementary treatments scale' and 'Conventional treatments scale' [26].

Somatosensory Amplification Scale (SSAS) [10] is a 10-item self-report scale, validated to assess the tendency to experience somatic and visceral bodily sensations as intense, noxious, and disturbing. Somatosensory amplification involves sustained self-examination and increased attention and vigilance to unpleasant somatic sensations, a predisposition to observe the weakest and rarest of somatic sensations, and a tendency to interpret them as dangerous signs of disease without any rational argument [10]. Participants rated ten statements (e.g. 'I am often aware of carious things happening in my body',

'When I bruise myself, it stays noticeable for a long time') on a five-point scale, where 1='not at all true' and 5='extremely true'.

The 'Conventional treatments scale' and 'Complementary treatments scale (CAM)' [26] asked participants to rate on a seven-point scale, from 1='definitely not' to 7='definitely', how likely would they be for a serious health matter to consult doctors and other medical practitioners and to take prescription medication, or to consult any complementary or alternative practitioners and to take supplements, vitamins or natural remedies.

The Multidimensional Health Locus of Control Scale (MHLC) [34], which consists of 'internal' (ILOC), and two external ('powerful others' – PLOC and 'chance' - CLOC) dimensions, measures the extent that one's behaviour is responsible for the health or illness of an individual. PLOC measures the perceived influence by healthcare professionals for personal health and CLOC - the degree to which one's health or illness depends on chance. MHLOC is rated on six-point Likert scales from 1=strongly disagree to 6=strongly agree. The PLOC, ILOC and CLOC are assessed by three statements regarding the patient's relevant health beliefs (e.g. 'No matter what I do, if I am going to get sick, I will get sick', 'Health practitioners control my health', 'The main thing which affects my health is what I do myself'). For each dimension the sum of items is calculated. A high score indicates a high importance of the locus of control in the given dimension.

The Hospital Anxiety and Depression Scale (HADS) [33] has been used in assessing anxiety disorders and depression in both somatic, psychiatric and primary care patients and in the general population. The scale consists of 14 items (7 each for anxiety and depression). Each item is rated on a four-point scale ranging from 0 (not at all) to 3 (very often). Responses are based on the relative frequency of symptoms over the preceding week. HADS has been found to have excellent internal consistency for the anxiety scale, and good

for the depression scale [35], as well as good validity for the anxiety subscale, and an excellent validity of the depression scale [36].

A section labelled 'Demographic information' asked the participants to indicate their sex, age, postcode and level of education.

Results

Of the 50 patients who completed the questionnaires (Figure 1), 29 (58%) reported having Irritable Bowel Syndrome (IBS), of whom 15 (30%) also reported having food intolerance (IBS+FI). A further twenty-one people (42%) reported food allergy or intolerance (FI) but not IBS.

Figure 1 Flowchart of the classification of participants by reported condition(s): irritable bowel syndrome (IBS), food intolerance (FI), and both IBS and FI.
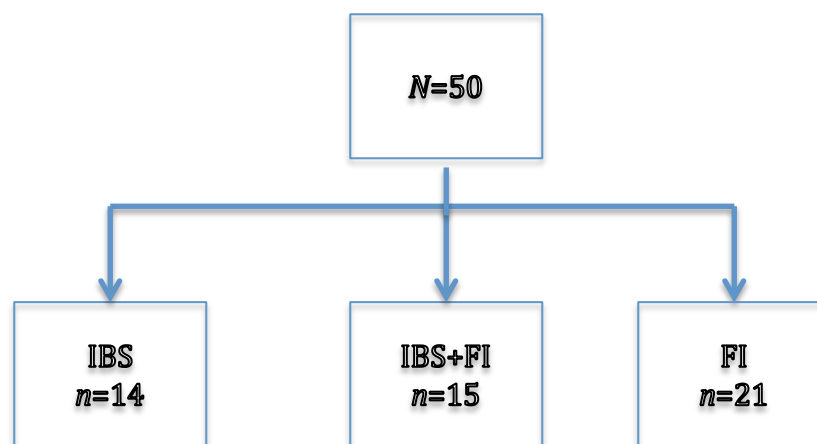
One-way ANOVAs conducted for all scales to explore differences between the IBS, IBS + FI, and FI groups on the following variables: Somatic symptom severity (PHQ-15), Somatosensory Amplification Tendency (SSAS), Anxiety and Depression (HADS) 'Orientation to Complementary and Alternative

medicine', 'Orientation to Conventional Medicine', 'Powerful Others HLOC',
'Chance HLOC', 'Internal HLOC', and the sub-categories of illness behaviour
'Professional Help', 'Think and Talk', 'Self-Help', and 'Ignore'. There were no
statistically significant differences between the groups on the variables:
'Orientation to Complementary and Alternative medicine', 'Orientation to
Conventional Medicine', 'Powerful Others HLOC', 'Chance HLOC', 'Internal
HLOC', and the sub-categories of illness behaviour 'Professional Help', 'Think
and Talk', 'Self-Help', and 'Ignore'. Table 1 reports results of one-way
ANOVAs conducted to explore differences between the IBS, IBS + FI, and FI
groups on these variables.

One-way ANOVAs with planned comparisons were conducted to compare
the responses by the IBS only, IBS + FI, and FI only groups on the following
variables: somatic symptom severity (PHQ-15), Somatosensory
Amplification Tendency (SSAS), Anxiety and Depression (HADS). Results
showed statistically significant group differences in symptom severity (F =
12.52, p < .001) and somatosensory amplification (F = 3.28, p =.046), with
the FI group reporting significantly lower levels of symptom severity and
somatosensory amplification, compared to both the IBS only and IBS+FI
groups . Planned comparisons confirmed a significant difference between
the FI group and the other IBS and IBS+FI groups in each case: PHQ-15, t =
5.0, p < .001, eta squared = 0.36 (large effect); SSAS, t =-2.56, p =.014, eta
squared = 0.12 (medium effect). No significant differences were found
between the groups for anxiety and depression. The results of the ANOVAs
and group means and standard deviations for these variables are also
presented in Table 1.

Table 1. Results of comparisons between FI only, FI+IBS and IBS only groups

	IBS		IBS+FI		FI		ANOVA	
	Mean	SD	Mean	SD	Mean	SD	F	*sig.*
Symptom severity (PHQ-15)	.98	.41	1.00	.37	.44	.32	12.52	.001
Somatosensory amplification (SSAS)	2.90	.63	2.93	.47	2.53	.48	3.28	.046
Depression	1.34	.74	1.34	.60	1.37	.86	.01	.987
Anxiety	1.36	.69	1.40	.70	1.24	.88	.21	.812
Orientation to CAM	4.07	1.23	4.53	1.15	4.04	1.42	.74	.484
Orientation to conventional medicine	5.63	.73	5.55	.76	5.80	.44	.75	.477
Powerful Others HLOC	3.18	.96	2.99	.96	3.06	1.03	.14	.874
Chance HLOC	3.20	1.04	3.02	1.13	2.86	.82	.51	.605
Internal HLOC	3.92	1.07	4.00	1.04	4.16	.79	.27	.762
Professional Help	2.97	1.54	1.58	1.40	2.24	1.81	2.57	.088
Self-Help	2.51	1.18	2.48	1.86	2.00	1.80	.52	.599
Ignore	.22	.13	.33	.17	.23	.19	1.98	.150
Think and Talk	2.77	1.07	3.24	3.08	2.03	2.30	1.22	.305

A follow-up chi-square analysis was conducted to compare frequencies of reporting of troublesome symptoms – those rated in the PHQ-15 as 'bothered a lot' – in the three groups. Six summary symptom categories were created as follows: 'Gastrointestinal symptoms' (stomach pain, constipation, loose bowels, or diarrhoea and nausea, gas, or indigestion); 'Bodily pain' (back pain, pain in arms, legs or joints, headaches); 'Anxiety-

related symptoms' (chest pain, dizziness, fainting spells, feeling heart pound or race, and shortness of breath); 'Fatigue' (feeling tired or having low energy, and trouble sleeping); 'Pain or problems during sexual intercourse', and 'Menstrual cramps'. Significant effects were found for gastrointestinal symptoms (χ^2 = 9.83 p = .007), bodily pain (χ^2 = 7.81, p = .020) and menstrual cramps (χ^2 = 6.04, p = .049). In all three cases, these symptoms appeared to be reported less frequently by the FI group (gastrointestinal 17.0%; bodily pain 10.6%; menstrual cramps 3.2%) compared to the IBS+FI group (gastrointestinal 25.5%; bodily pain 23.4%; menstrual cramps 16.1%) and the IBS group (gastrointestinal 27.7%; bodily pain 19.1%; menstrual cramps 9.7%).

For people who reported having both IBS and food intolerance (IBS+FI), a paired-samples t-test was conducted to evaluate the differences in the degree to which they perceived each of these conditions as threatening on the BIPQ. There was a statistically significant difference (t = -2.57, p = .017) between the illness perception of food intolerance (M=5.73, SD=1.26) and that of IBS (M=6.22, SD=1.20), where the higher mean score for IBS reflects a more threatening view of the illness.

Discussion

The lack of consistent findings in the literature regarding significant associations between food intolerance and psychogenic factors has cast doubt on the role of anxiety, negative affect and somatosensory amplification on the perception, severity and maintenance of symptoms, suggested by studies of clinical samples. This study investigated the hypothesis that severe and amplified reactions to symptoms, often ascribed by researchers in previous studies as leading individuals to associate these symptoms to

perceived food intolerance, are more likely a pattern of response in patients with IBS-like symptoms.

This hypothesis was supported in several steps: Firstly, our study results showed that participants reporting IBS or both IBS and food intolerance reported significantly more severe symptoms and scored significantly higher on somatosensory amplification tendency than those reporting food intolerance only. Secondly, more than half of the IBS patients reported concurrent food intolerance, a finding in accord with the prevalence rates of food intolerance amongst IBS patients reported in previous studies [5; 7; 37]. Thirdly, the ratings from the illness perception questionnaire for each condition - food intolerance and IBS, within the group reporting both food intolerance and IBS, indicated that food intolerance was perceived as more benign and less threatening than IBS. This is in accord with the relatively low lifestyle impairment and use of health care resources in reported food intolerance, shown in larger non-clinical studies [38].

Several potentially important points emerge from our results. The higher number of severe, disturbing symptoms reported by the patients in both IBS groups relative to the food intolerance group indicates that the apparently severe responses to symptoms are not peculiar to the perception that one has a food intolerance, but accompany a state of health, of which a diagnosis of IBS is a marker. This suggests the possibility that the high number of gastrointestinal symptoms and the relatively extreme and amplified reactions to symptoms, considered to be a characteristic of perceived food intolerance in previous studies may indeed be only responses to the presence of IBS. A further question arises, of whether having a diagnosis of IBS is related to gastrointestinal symptom-specific anxiety, which in other studies has been found to be a significant predictor of gastrointestinal complaints in people with perceived food intolerance [39]. Therefore, a question of interest and for investigation in future research is the role of

gastrointestinal specific anxiety, which may be potentially triggered by the presence of an IBS diagnosis, in the experience of severe and amplified responses to symptoms.

It should be acknowledged that, although no significant differences were found between the three groups in levels of anxiety, depression, health locus of control, receptiveness to conventional or complementary and alternative medicine, and illness behaviour, limited statistical power due to a modest sample size is likely to have played a role in some of these results not reaching level of significance. The limited sample size also poses the risk of making a Type II error (failing to detect an effect that is present) in the interpretation of the results. Recommendations for future research therefore include studies with larger samples, with a clear distinction of whether any observed psychological characteristics apply to food intolerance alone, or with concurrent IBS. More attention should be paid to the concept of illness behaviour, as the categories of responses grouped into the factors 'Professional Help' and 'Ignore' in our analyses have approached near-significant effects. Future studies should particularly focus on the contribution of having IBS to mediating the illness experience of patients with food intolerance.

Conclusion

Previous studies have directed our attention to a potentially important role of the tendency to be vigilant in respect of symptoms and to experience these symptoms as more intense, noxious, and disturbing in the perception and maintenance of food intolerance.

In this study we found that the tendency to amplify symptoms and attribute them to a threatening disease was weaker in patients with food intolerance, compared to the groups, where a diagnosis of IBS is present. In addition, it

was indicated that the high number of severe, disturbing symptoms accompany the presence of a diagnosis of IBS, and are not peculiar to the perception that one has a food intolerance. Potential questions for future research include whether having a diagnosis of IBS is related to gastrointestinal-specific anxiety, which has been found in other studies to be a feature of patients with perceived food intolerance, and has been significantly associated with severity of gastrointestinal symptoms [39]. Future research should make a clear distinction whether any observed psychogenic characteristics apply to food intolerance alone or with concurrent IBS and include a more thorough investigation of the role of IBS in mediating the illness experience of food intolerance.

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Chapter 6. Discussion, implications and future directions

    1.   **Background**

The definitions of food allergy and food intolerance are the subject of ongoing discourse in the immunological, clinical, psychological, sociological and anthropological literature. Although there appears to be some understanding of the meaning of these definitions, on closer look 'food allergy' and 'food intolerance' are both regarded as unsteady concepts (Nettleton, Woods, Burrows, & Kerr, 2009; Nettleton, Woods, Burrows, & Kerr, 2010), the result of various diagnostic processes. In a study, which explored sociological debates on food allergy and intolerance, Nettleton et al., (2009) described the roles of the "others", or the various social participants involved in formulating their definitions. The authors have suggested that health professionals, scientists, governmental agencies, campaign groups, the media and lay people have a significant contribution to shaping the definitions of food allergy or intolerance. Nettleton et al. (2009) have described the "object" of food allergy and intolerance as fluid and uncertain, a problem also magnified by the range of commercial, for profit-oriented or alternative health providers who claim to offer a variety of services, advice, diagnostic tools and treatment.

Understanding the definitions of food allergy and food intolerance requires understanding their meanings from a medical and lay point of view, one relying on firmly set scientific, laboratory and epidemiological testing and the other, on the process of perception, interpretation and personal condition (Nettleton et al., 2009). The accepted medical view on food allergy is that it is an adverse immune reaction to a food protein (an antigen) that

the immune system does not recognize as safe (Nettleton et al., 2009; Skypala & Venter, 2009). In response, the body's immune system produces a specific antibody from the Immunoglobulin E (IgE) class. These IgE antibodies react with a certain food and produce symptoms, which can include skin rash, swelling of the throat, lips or tongue, trouble breathing, stomach pain, vomiting, or diarrhoea (Skypala, 2011). Sometimes these symptoms are very severe and can be life threatening.

However, research on the prevalence of food allergy and intolerance frequently discusses the phenomenon of perceived food intolerance (Rona et al., 2007; Teufel et al., 2007; Young, Stoneham, Petruckevitch, Barton, & Rona, 1994; Kanny, Flabbee, Morisset, & Thevenin, 2001; Schäfer, Ruhdorfer, Wessner, Filipiak, & Ring, 2001; Zuberbier, Worm, Reimann, Roehr, & Niggemann, 2004; Niestijl Jansen et al., 1994), and that of the 'perception gap' whereby information obtained from self-report questionnaires can overestimate the prevalence of food allergies (Bjorksten, 2001). It is not surprising therefore that studies have found significant discrepancies between rates of self-reported (perceived) food intolerances and genuine food allergy, which can be confirmed using blood tests and double-blind placebo-controlled food challenges (DBPCFC) (Teufel et al., 2007; Young et al., 1994; Kanny et al., 2001; Rona et al., 2007; Schäfer et al., 2001; Zuberbier et al., 2004; Niestijl Jansen et al., 1994).

One of the prevailing explanations for the increased levels of perceived food intolerance lies in its association with the use of CAM (Nettleton et al., 2010). It has been suggested that when patients do not receive a confirmed diagnosis of food allergy, or disagree with it, they may turn to alternative sources of medical advice such as complementary and alternative practitioners (Barnes, Powell-Griner, McFann, & Nahin, 2004). Their support can incline patients to challenge the medical profession by rejecting doctor's expertise (Ebeling, 2011). Alternative or complementary methods of

diagnosing and treatment of food intolerance have risen in prevalence and popularity and they aim to be recognised as credible in the growing allergy market (Nettleton et al., 2009). Conventional medicine has rejected these methods of diagnoses and care as invalid or risky, but despite this complementary and alternative medicines have been increasingly prescribed over the counter on the guarantee to boost the immune system against the complex modern life (Petrie, Booth, Elder, & Cameron, 1999; Senna et al., 1999; Senna et al., 2000).

Yet another explanation lies in research conducted by allergists and clinical immunologists, which explores the association between psychosocial and psychogenic characteristics and self-reported food intolerance (Lied et al., 2011; Lillestøl et al., 2010; Berstad, Arslan, Lind, & Florvaag, 2005; Bell, Schwartz, Peterson, & Amend, 1993; Rix, Pearson, & Bentley, 1984). This research is mostly clinical in its orientation and it is aimed at forming a better understanding of the needs of the patients suffering from allergy or intolerance, with a view to improving service quality. Some of the limitations of this body of research provide a background for understanding the gaps in the literature of perceived food intolerance, which this thesis has tried to address.

In addition to the mostly clinical nature of the studies of perceived intolerance, research findings have almost exclusively revolved around the possible contribution of psychogenic factors. While this is consistent with most models of unexplained symptoms (Ursin, 1997; Barsky et al., 1990), it can result in an overestimation of the relationship between physical symptoms and perceived illness (Rief & Broadbent, 2007) and place perhaps too much emphasis on the importance on the role of anxiety, negative affect and somatosensory amplification to the formation, perception and attribution of symptoms and illness beliefs. Currently in the literature on perceived food intolerance, the contribution of non-psychogenic factors to this process has not been sufficiently examined.

2.   Review of the aims of the thesis

As a starting point the focus of this thesis were the findings of a national population survey on the motivations for wheat avoidance in Australia (Golley, Corsini, Topping, Morell, & Mohr, 2015), which questioned the central role of psychogenic factors, including anxiety and neuroticism, suggested by previous clinical research, as predisposing some individuals to attribute symptoms to the consumption of certain foods (Lied et al., 2011; Rix et al., 1984; Lillestøl, et al., 2010; Berstad et al., 2005; Bell et al., 1993; Pearson, Rix, & Bentley, 1983; Lind et al., 2010). The findings of Golley et al. (2015) provided a different perspective on food avoidance behaviour and challenged the presumption that symptomatic food avoidance in the general population is the result of atypical psychopathology. Golley et al. (2015) found that the decision to avoid wheat appeared to be influenced substantially by information from non-medical sources, and was predicted by increased receptiveness to complementary medicine and lesser receptiveness to conventional medicine. There were no significant effects for neuroticism, worry about illness or illogical reasoning. More importantly, the findings of the study suggested a tendency of people to exercise control over their health through the elimination of foods thought to cause discomfort, as part of a possible trend towards non-medical or self-diagnosis and self-management of symptoms.

The aims formulated at the beginning of the thesis were as follows:

- To extend understanding of the predictors of food avoidance in the Australian adult population beyond wheat avoidance to dairy avoidance. As part of that to investigate the symptoms, diagnoses, and the potential for misattributions leading to self-prescribed food avoidance. This aim was

addressed in the first study: 'Food avoidance in an Australian adult population sample: the case of dairy products.'

- To explore and understand the associated symptoms, the sources of diagnosis, and the psychological predictors of reporting of non-medically diagnosed (NMD) and medically diagnosed (MD) food intolerances in the Australian population. This aim was addressed in the second study: 'Prevalence and psychological predictors of medically and non-medically diagnosed food intolerance in Australia'.

- To explore whether somatosensory amplification, previously described, as a predisposing condition that leads to perceived food intolerance through the process of somatisation, is a function of the experiencing of severe symptoms, rather than a cause of the condition and its symptoms. This aim was the focus of the third study: 'IBS and food intolerances: differences in somatic symptom severity, somatosensory amplification and illness perception'. This study explored the characteristics associated with food intolerance in the context of those associated with IBS, as a representative of the class of functional somatic disorders.

3.   Thesis findings

Several key results emerged from the series of studies presented in this thesis.

3.1. Study 1

The follow-up study of symptomatic dairy avoidance found, as previously for wheat, that the avoidance of dairy appeared to rely substantially on a non-medically diagnosed connection between ingestion and symptoms. An

important finding of this first study was that the avoidance of dairy, but not wheat was predicted by worry about illness. The implications of this finding are significant as it outlines the different predictive profiles of two avoidant populations as different psychosocial phenomena. The avoidance of dairy appears to be associated with an internal focus on the possibility of illness rather than the external focus on non-conventional medicine treatment strategies, which was associated with the avoidance of wheat.

The role of illness worry, which was measured with four items from the Whitely index for the assessment of hypochondriasis, may be twofold. The extreme form of illness worry, hypochondriasis, has been understood as a disorder of perception and cognition (Barsky & Klerman, 1983). Hypochondriacs may be unusually sensitive to, and intolerant of, bodily sensations in general, and be more likely to attribute them to disease. Hypochondriacs have been found to amplify normal physiological functions, bodily sensations, and symptoms caused by emotional arousal and thus have been characterised as having an amplifying perceptual style (Barsky et al., 1990). Another possibility is that illness worry is reactive, being provoked by perceived unusual changes in bodily functioning, exposure to negative information about health that is personally significant, or bodily sensations that are catastrophically interpreted. What remains to be determined, therefore, is to what degree dairy avoidance is the behaviour of a more symptom-vigilant population or an outcome of severe or distressing symptoms. That question is beyond the scope of this thesis.

The findings from the dairy avoidance study broadly suggested two further research questions, which became subjects for investigation in Study 2. First, the null effects observed for neuroticism and illogical reasoning style suggest again, as found for wheat avoidance, that the avoidance of dairy products for the management of perceived symptoms may not be the result of atypical psychopathology. The possibility remains that this behaviour is related to

more unremarkable, non-psychogenic individual-level characteristics that incline some individuals to attribute distressing symptoms to the consumption of certain food items or components. Many of these symptomatic dairy or wheat avoiders, without the supporting evidence from medical practitioners, would perceive themselves as food intolerant. Therefore, of interest was to further investigate the responses only of those, who avoid a dietary factor because of symptoms they associate with its consumption. Secondly, the differential findings for illness worry raised the possibility that symptom-related psychological distress might be a response, rather than antecedent to symptoms. That prompted the question whether a phenomenon like somatosensory amplification is peculiar to non-medically diagnosed food intolerances or also observed in cases of medically diagnosed food intolerance.

3.2. Study 2

The results of Study 2, which addressed the nature, prevalence, and psychological predictors of both non-medically diagnosed and medically diagnosed food intolerances in an Australian population sample, confirmed that a significant proportion of adult Australians classify themselves as food intolerant without a supporting medical diagnosis. Approximately three quarters of people reporting intolerances reported non-medically diagnosed intolerances: intolerances that were either CAM diagnosed, or otherwise not formally diagnosed.

The study findings, in accord with study 1, showed a much higher reported prevalence of gastrointestinal symptoms than any other symptoms. Reporting a medically diagnosed intolerance was associated with a less analytical thinking style and greater receptiveness to conventional medicine, whereas reporting a non-medically diagnosed intolerance was predicted by greater receptiveness to CAM. The tendency to report an intolerance – whether medically diagnosed or a non-medically diagnosed – was

significantly predicted by somatosensory amplification tendency and health locus of control involving a relative rejection of powerful others, which usually implies doctors and other medical specialists.

These findings raised several points for discussion. First, null effects for neuroticism for non-medically (as for medically) diagnosed intolerances were inconsistent with the central role of anxiety and negative affect suggested by studies, mostly of clinical samples, which associated these psychogenic factors with somatization mechanisms of heightened perception and misattribution of bodily symptoms (Berstad et al., 2005; Pearson et al., 1983; Rief & Broadbent, 2007).   An additional inconsistency with this line of reasoning was presented by the finding that somatosensory amplification predicted reporting of medically diagnosed as well as of non-medically and medically diagnosed intolerances. Previous clinical research has described somatosensory amplification as a predisposing condition to perceived food intolerance through the process of somatisation, and as such, a possible manifestation of the same biomedical or psychosocial processes leading to frequent and severe symptoms in functional somatic syndromes. However, the significant association of somatosensory amplification with both medically and non-medically diagnosed food intolerance questions its suggested role in the in the cause, maintenance, and exacerbation of symptoms of perceived intolerance only. Rather, it presents a novel perspective to the role of somatosensory amplification, as a normal tendency resulting from the one's expectation that the ingestion of certain foods would cause particular adverse reactions. This approach puts doubt on the presumption that the high prevalence of self-diagnosed food intolerance in the general population is the result of psychopathological factors. While it does not rule out the possibility that extra-vigilance and sensitivity may help maintain and amplify the experience of symptoms, it suggests that such an effect will not be peculiar to non-medically diagnosed or perceived intolerances.

The association between reporting of non-medically diagnosed intolerance and receptiveness towards complementary and alternative medicine has pointed to the potential role of social factors in perceived intolerances. The tendency of individuals to attribute adverse symptoms to the consumption of food, without medical evidence or diagnosis, and a positive orientation to CAM has often been the subject of discussion in the sociological and anthropological literatures (Nettleton et al., 2009; Nettleton et al., 2010; Haeusermann, 2015). The choice of food has been increasingly thought of as becoming part of expressing individual and social identities, and can be representative of a certain socio-economic status, and a type of contemporary social lifestyle (Nettleton et al., 2010). Having a diagnosis, including a self-diagnosis, has been described as a cultural phenomenon, a way of categorising a condition, self and others, as defining one's identity, and as a meaning of what is normal and not normal (Ebeling, 2011).

Being in control over one's body, being able to manage symptoms and identify sources of discomfort is a goal expressed in many food intolerance discourses (Nettleton et al., 2010). Having a diagnosis and symptoms, which have a scientific explanation, such as "food allergy" or "food intolerance", is found to support a genuine sickness identity in individuals, who perceive themselves as food intolerant (Nettleton et al., 2010; Haeusermann, 2015). Food intolerance discourses reveal that those who experience symptoms associated with food intolerance think of themselves as having a marginal and questionable status and wish for a diagnosis that will legitimise their symptoms by giving them a name (Nettleton et al., 2009). For people who support this view, establishing a diagnosis can be an uneasy process of gaining legitimate status. Not receiving support from medical doctors may shift the patient towards alternative therapies (Moore, 2014; Jutel, 2009). In summary, the contribution of these social factors may be a way of explaining

the significant association found in our study between reporting a non-medically diagnosed intolerance and greater receptiveness to CAM.

3.3.   Study 3

The found association in Study 2 between somatosensory amplification and the reporting of medically as well as non-medically diagnosed food intolerances raised the question whether the extra-vigilance and tendency to amplify symptoms observed in clinical studies of perceived food intolerance may be a function of the experiencing of severe symptoms and is therefore a consequence rather than a cause of the condition. The reported overlap in symptoms between IBS and food intolerance (Frissora & Koch, 2005), the high prevalence of perceived food intolerance among subjects with IBS (Böhn, Störsrud, Törnblom, Bengtsson, & Simrén, 2013) and the severity of symptoms frequently identified in IBS patients, raised the possibility that relatively extreme and amplified reactions associated with food intolerance in clinical studies are responses to the presence of IBS-like symptoms.

Study 3 focused on the pattern of psychological responses in patients with food intolerance, food intolerance and IBS, and IBS, and investigated the hypothesis that patients reporting food intolerance only would differ from IBS patients and patients with both IBS and food intolerance in symptom severity, somatosensory amplification tendency, as a measure of extra-vigilance, perception of severity of illness, and illness behaviour. The study also explored differences between the patients on psychological features, including health locus of control, anxiety and depression, receptiveness to complementary and alternative medicine, and receptiveness to conventional medicine. Several important results emerged from the study. Firstly more than half of the IBS patients reported concurrent food intolerance, which is in accord with the prevalence rates of food intolerance amongst IBS patients reported in previous studies (Böhn et al., 2013). Secondly participants reporting IBS or both IBS and food intolerance reported significantly more

severe symptoms and scored significantly higher on somatosensory amplification tendency than those reporting food intolerance only. Thirdly food intolerance was perceived as a more benign and less threatening condition than IBS by people who reported both.

To summarise, Study 3 found that the tendency to amplify symptoms and attribute them to a threatening disease was weaker in patients reporting food intolerance than those reporting IBS, with or without food intolerance. Although the possibility is not excluded that people who report food intolerance alone are providing less distressing symptoms because they have managed their food intolerance with food avoidance diets, the findings support the view that the experiencing and anxiety about severe, disturbing symptoms accompany a state of health of which a diagnosis of IBS is a potential marker and are not peculiar to the perception that one has a food intolerance.

4. Strengths and Limitations

The research conducted in this thesis has both strengths and limitations. Strengths of the research include the use of a probability sample in Study 1 and Study 2, drawn from the Australian population and of sufficient size to allow the study of minority sub-populations. In each of these studies, three thousand surveys were distributed to a proportional stratified random sample of voters selected from the eight States and Territories of Australia by the Australian Electoral Commission. In both studies, observed gender and age distributions were significantly different from population estimates, with women and older people over-represented. The data were weighted to adjust for this to be able to provide a more exact calculation of population prevalence estimates. The risk of social desirability bias was lessened by participant anonymity and the embedding of the studies in a larger omnibus-

style survey format offered protection against the cuing of participants to respond in certain ways.

There are several limitations of the series of studies conducted in this thesis, including limitations of the sampling framework and data measurement, which limit the interpretation, generalizability, and conclusions that can be drawn from these results. Many of these limitations have been outlined in detail in each of the papers, and will therefore be discussed only briefly here.

Limitations of the sampling framework include the possibility of sampling bias in favour of people with an interest in food or health, even though in Study 1 and Study 2, care was taken with the cooperation of the Australian Electoral Commission to obtain a nationwide representative sample. Other limitations include the limited ability to examine differences in responses due to race or ethnicity and not including in the estimate of food avoiders those adults with symptom-unrelated explanations and other members of avoiders' families, including children, passively exposed to avoidance diets. In Study 3, limited statistical power, due to a modest clinical sample size is likely to have played a role in some of the results not reaching level of significance and therefore represents a limitation, recommended for addressing in future studies with larger samples.

Limitations in the research also include the practice by study participants of using the terms food allergy and intolerance interchangeably. The term "food allergy" has often been perceived by lay people as all encompassing, describing all reactions, from mild to severe, believed to be associated with ingestion of food. In our studies, evidence for this was the number of reported allergies, which were claimed by the participants to be non-medically diagnosed. Another noteworthy limitation is that any claims of medical diagnoses could not be confirmed, as there was no information requested from participants on whether they were diagnosed by a formal

allergy blood test, other medical tests, or by way of doctor's recommendation. The inability to substantiate participants' reports should not, however, be a significant impediment to the interpretation of these reports, as it is participants' beliefs in the existence of medical endorsement that is important, whether factually correct or not.

4.1.   The 'Perception gap' - an increase in the prevalence of food allergies or data derived from self-report questionnaires?

Limitations in the research also lie in the reliance on self-report data. Studies on the prevalence of food allergy refer to the problem of the 'perception gap' whereby information obtained from self-report questionnaires can misleadingly indicate an increase in the prevalence of food allergies (Bjorksten, 2001). As a result, it is often suggested and assumed that the incidence of food allergy is increasing (Kimber & Dearman, 2002).

Our data, collected in all three studies on symptoms, diagnoses, and medical conditions are participants' accounts of these based on their memory and interpretation. Recall bias, social desirability bias, and errors in self-observation can cause inaccurate self-reporting. Participants may also vary in their understanding or interpretation of particular questions. Furthermore, the term 'food intolerance' is subjective and is based on expectations and cultural perspectives. Various symptoms from the gastrointestinal tract or other organs may thus be commonly ascribed to intolerance in one society, but not in another (Bjorksten, 2001).

5.   Significance, implications and future directions

The potentially adverse public outcomes of perceived food intolerance, in particular the self-management of symptoms through the practice of

eliminating foods, or food components, make it surprising that so little is known in Australia about its true prevalence, psychological and physiological aetiology, or its impact on diet adequacy and quality. For this reason, a systematic investigation was required to determine what proportion of adults are potentially affected, and the psychological and behavioural profiling of those avoiding foods for a variety of reasons, including perceived food intolerance. This research aimed to identify and classify their characteristics and associated experiences, symptoms, diagnoses and information sources that have led them to this decision.

It is believed that the research undertaken as part of this thesis, is the first of its kind, conducted in Australia, to investigate not only the prevalence, but also clustering, associated symptoms, and psychological predictors relating to food avoidance and food intolerance. Further, while the discrepancy between medically confirmed food allergy and intolerance and perceived food intolerance has been documented, the mechanisms underpinning this difference were still unclear. This research was the first to investigate the roles of both psychogenic and non-psychogenic factors in the decision processes relating to not only perceived, but also medically diagnosed food intolerances in a non-clinical community population. It also adds significantly to the literature on the growing trend amongst non-coeliacs to self-diagnose as "gluten intolerant" and exclude gluten and wheat from their diet.

The potential number of Australians involved, revealed by the research in this thesis makes both perceived food intolerance and the behaviour of food avoidance significant public health issues. The research findings provide currently unavailable information about their prevalence and associated psychological characteristics to medical practitioners, who might be unaware that such a large number of people eliminate nutritionally important foods or perceive themselves as food intolerant. The results from

the thesis are also beneficial to future researchers, who wish to embark on the suggested directions for investigation of the experiences that have led a significant part of the Australian population to take such a path. The research findings from this thesis will be disseminated through the delivery of peer-reviewed scientific journal articles and presentations to scientific, government and industry bodies. As a result, they would not only address the interests of individuals affected by food allergy or intolerance and medical practitioners, but would be also potentially of benefit to policy makers, industry, research and organisational strategies, such as those of The Grains Research and Development Corporation (GRDC), The Dairy Industry Association Australia (DIAA), The Australasian Society of Clinical Immunology and Allergy and others.

The health behaviour described in this thesis has important implications resulting from the tendency of individuals with perceived food intolerance to self-manage their symptoms and to adhere to elimination diets. These implications include health risks for individuals, such as unnecessarily restrictive diets, malnourishment, eating disorders, or misinterpreting of symptoms and misdiagnosing more serious conditions (Teufel et al., 2007). Studies of patient groups with prescribed exclusion diets – e.g., people with celiac disease, who make up 1% of the population – also document the substantial costs of these to both patient quality of life and public health budgets Hallert et al., 1998; Long et al., 2010).

Research has shown that people with perceived food intolerance take significantly more time off per year than healthy controls, and physical activity and daily routine such as sport and travelling is affected (Knibb et al., 1999). Adolescents with perceived intolerance have shown significantly lower scores on role functioning-physical, bodily pain, general health, vitality, social functioning, role-functioning-emotional and mental health (Health

Survey Short Form SF-36), than their peers (Marklund, Ahlstedt, & Nordström, 2004).

An important possibility exists that there is a sound reason to some self-diagnosed associations between symptoms and the consumption of particular foods. There is current medical interest in whether there is such a thing as non-coeliac gluten sensitivity, on the basis of the belief that an unknown, but believed to be considerable, proportion of the population, is avoiding gluten (Holmes, 2013; Aziz & Sanders, 2012; Zanini et al., 2015). The current research catalogues symptoms associated with allergenic and non-allergenic food hypersensitivity and commonalities or clusters of symptoms across different foods and therefore is beneficial to the future investigation of mechanisms that may underlie unrecognised sensitivities.

As discussed earlier in the thesis, the findings with respect to the aetiology of this phenomenon have indicated that the high prevalence of self-diagnosed food intolerance in the general population is unlikely to be the result of atypical psychopathology. In this context, it is possible that the behaviour observed here might be substantially explained by the expanding market for gluten-free, lactose free, preservative-free products, and is perhaps motivated by a shift in the doctor-patient relationship, towards alternative therapies and challenging of doctor's authority. It is also possible that the behaviour of food avoidance is part of a more general and increasing public trend towards self-diagnosis, management of symptoms, and desire for control over one's health. If so, having a medical substantiation for food intolerance would be regarded as less urgent, and having any diagnosis, including self-diagnosis over which participants have ownership, would give them power to exercise control over their health (Nelson & Ogden, 2008).

Other explanations for the large discrepancy between medically- and self-diagnosed food intolerance were also discussed in this thesis. One such

explanation is the difficulty in distinguishing food allergy or intolerances from functional and organic disorders, highlighted by previous studies (Berstad, et al., 2005; Berstad, Undseth, Lind, & Valeur, 2012; Bhat, Harper, & Gorard, 2002). Our findings have provided little support for a possibility that food intolerance may be another manifestation of the same psychosomatic or physiological processes associated with functional somatic syndromes, such as IBS. Extra-vigilance and amplification of symptoms and a high number of severe, disturbing symptoms were found not to be peculiar to the perception that one has a food intolerance. Instead, our findings have suggested that these characteristics, often credited by researchers in previous studies as leading to perceived food intolerance, may indeed result from the presence of IBS-type symptoms and an IBS diagnosis. This possibility provides an interesting direction for future research. Recommendations for future research include larger studies, with a focus on the role of IBS diagnosis in the illness experience of patients with food intolerance, and with a clear distinction of whether any observed psychological characteristics apply to food intolerance alone, or with concurrent IBS. More future population studies of symptoms attributed to food intolerance are necessary with an interdisciplinary approach, attending to psychological, dietary, gastroenterological, neurological, and allergenic aspects of this condition. More studies are also required from different world regions in order to identify similarities and differences in the patterns of perceived or actual food allergy and intolerance, as the cultural and social perceptions of both would be expected to have a major impact on their reported prevalence.

Final comments on the overall implications of the thesis findings

Past studies of perceived food intolerance in the behavioural literature have suggested that misperception of food intolerance largely arises from a psychiatric disorder or distorted cognitive style. It has been suggested that

one of the most common reasons for attributing adverse symptoms to food is a psychosomatic reaction, caused by anxieties about a particular food, which could cause pathophysiological changes similar to real immunological reactions (Berstad et al., 2005). This has led to formulation of the view that food hypersensitivity might be a sensitisation disorder, not due to immunological mechanisms but rather at a cognitive-emotional level (Berstad et al., 2005). Because this work was based on studies with patients from (mostly allergy) clinics, these findings have provided a limited explanation for the pathogenesis and maintenance of perceived food intolerance. A gap in the literature was identified in the need for larger studies, more representative of the general population. This thesis has aimed to address this gap by investigating both psychogenic and non-psychogenic predictors of food avoidance and food intolerance in two studies with large Australian population samples.

The findings of this thesis challenge the view of perceived food intolerance as having its origins in psychological dysfunction. Findings from Study 3 further suggest that attributing adverse symptoms to specific foods is unlikely to be due to psychosomatic reactions of the kind observed in functional somatic syndromes: Extreme responses to symptoms were found not to be peculiar to the perception that one had a food intolerance, but to accompany a state of health of which a diagnosis of IBS was a marker. The picture that emerges from these findings is one in which vigilance about symptoms is more plausibly a response to the experience of distressing symptoms than a precursor to the belief that one has food intolerance. The overall impressions are that significant numbers of people with perceived food intolerance do not have a medical diagnosis regarding their symptoms, and treat themselves by eliminating the foods in question from their diets. The origins of this behaviour appear to fall largely outside mainstream medicinal practice, with significant influence from complementary and alternative medicine. This behaviour may indeed explain the expanding

market for lactose-free and gluten-free products and the increase in the number of CAM practices, which seem to offer multiple forms of services, including advice, products, and therapy (Nettleton et al., 2010; Senna et al., 1999; Senna et al., 2000). It also may reflect a tendency of people to exercise control over their health and to feel responsible for managing the risks of food intolerance, which have been implicated within popular and scientific discourses as being the result of modern production, chemicals, use of anti-bacterial products, changes in hygiene practices, antibiotics, genetically modified foods and other external factors (Nettleton et al., 2009; Nettleton et al., 2010).

Chapter 7. REFERENCES

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APPENDIX A: Paper 1 Reprint

Food avoidance in an Australian adult population sample: the case of dairy products

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Abstract

Objective: To assess the prevalence of and explanations for the avoidance of dairy foods, including symptoms attributed to their consumption, diagnoses and psychological predictors of avoidance. Also considered were comparisons with symptom-related avoidance of wheat in the same sample.

Design: Cross-sectional population survey.

Setting: The study was conducted in Australia using a national postal omnibus survey.

Subjects: Adults aged 18 years and over (*n* 1184; 52·9 % female) selected at random from the Australian Electoral Roll.

Results: Despite few claims of formally diagnosed allergy or intolerance, 11·8 % of the sample reported avoiding dairy products because of adverse physiological effects, which commonly included gastrointestinal symptoms. Unlike wheat (3·5 %) or wheat-and-dairy (3·6 %) avoidance, dairy avoidance (8·2 %) was predicted by age (negatively) and worry about illness (positively).

Conclusions: The findings are further evidence of a widespread tendency for consumers to exercise control over their health by eliminating dietary factors considered suspect without medical evidence or oversight. Unanswered questions include the decision processes underlying dairy avoidance, whether symptoms are attributed correctly, the agents and physiological mechanism(s) involved, the relative contributions of symptom severity and vigilance to the association with illness worry, and the nutritional adequacy of dairy avoiders' diets. Irrespective of the accuracy of self-diagnoses, if the elimination of suspect foods is an end in itself the paradoxical possibility for nutritional imbalances may have significant public health implications.

The benefits of the consumption of dairy foods are numerous. They are the biggest source of Ca in the Australian diet and whole milk and other dairy foods provide a unique package of other essential nutrients including protein, vitamins (A, B_{12} and riboflavin) and minerals (P, Mg, K and Zn)[1]. Not consuming these foods risks insufficient dietary Ca intake and has been known to result in reduced bone mineral density, increased incidence of fracture, and other risks to health and well-being[1–3].

National information about the prevalence and drivers of avoidance of dairy products is scarce in Australia. The Australian Bureau of Statistics reported that in 2011–12, 17 % of Australians aged 2 years or over (3·7 million people) reported avoiding a food due to allergy or intolerance, with cow's milk and other dairy products (4·5 %) being the most commonly claimed source of intolerance[4]. Because these figures relate only to cases of food avoidance specifically attributed by interviewees to an allergy or intolerance, they can be expected to underestimate – perhaps substantially – the population prevalence of avoidance of any given food, including dairy foods.

In a national population survey, 7 % of apparently non-coeliac Australian adults reported avoiding consumption of products containing wheat for the alleviation of physical symptoms. In the great majority of cases, these related to the gastrointestinal system and included those that are diagnostic of irritable bowel syndrome (IBS) according to the ROME 2 criteria. Wheat avoidance occurred overwhelmingly in the absence of a formal diagnosis and was predicted by receptiveness to complementary medicine (positively) and conventional medicine (negatively) but not by measures of anxiety or illogical reasoning style. Questions arising from these findings relate, *inter alia*, to the possible physiological mechanisms underlying symptoms, the decision processes leading to self-prescribed avoidance of wheat and the potential for nutritional imbalances[5].

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Compounding these questions, however, is the additional finding that 53 % of self-identified symptomatic wheat avoiders also reported, in a separate sub-section of the same omnibus survey, that they were avoiding consuming dairy foods. This points to a possibly widespread phenomenon of poly-avoidance with significant implications for both the development of nutritional imbalances – through the compensatory overconsumption of other foods as well as the avoidance – and the task of identifying a specific food component as a source of symptoms. Where wheat avoidance and dairy avoidance are concerned, it also prompts the question whether these are discrete or intrinsically related phenomena.

Using data from the same survey, the present paper addresses the prevalence of and explanations for dairy avoidance, including reported symptoms, diagnoses and influences, as well as possible psychological predictors of and health conditions correlated with dairy avoidance behaviour. This is the same set of measures as used in the wheat avoidance study[5]. The psychological characteristics considered thus include neuroticism, tendency to worry about illness, propensity for a less analytical and/or more intuitive reasoning style, and receptiveness to each of conventional and complementary medicine. Of key interest throughout are commonalities with and differences from the case of wheat avoidance.

Method

Participants and study design

Data for the current study were obtained from a cross-sectional survey of attitudes and behaviours related to health, diet, foods and food characteristics in an adult Australian population sample selected at random from the Australian Electoral Roll. The data were collected through the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) 2010–11 Food and Health Survey. Detailed data collection methods and procedure are described elsewhere[5]. One thousand one hundred and eighty-four of a possible 2867 postal surveys were returned completed (an overall response rate of 41·3 %). The sample consisted of adults aged 18 years and over: 527 males (44·5 %), 626 females (52·9 %) and thirty-one not specified (2·6 %); mean reported age was 51·64 (sd 16·78) years. Women (χ^2 (1, n 1148) = 6·02, $P = 0·01$) and older people (χ^2 (6, n 1144) = 149·78, $P < 0·01$) were over-represented relative to the population; the data were weighted to adjust for this in the calculation of population prevalence estimates.

Procedure

The CSIRO Food and Health Survey was a 200-item postal omnibus survey distributed nationally in December 2010; participation was anonymous. The study was conducted according to the guidelines laid down by the Declaration of Helsinki and the research protocol was approved by the CSIRO Human Research Ethics Committee.

Variables

The questionnaire contained a section labelled 'Avoidance of wheat and/or dairy products'. Responses to the avoidance of wheat products are reported elsewhere[5]; an identical set of questions addressing the avoidance of dairy products is the focus of the present paper. Questions asked whether the participant avoided all or certain dairy products and to specify which; to state the main reason for avoiding the consumption; to identify any reactions to dairy consumption from a list of eighteen physiological and psychological symptoms; to indicate on a 3-point scale ('not at all', 'somewhat', 'very much') the extent to which each of seven medical or non-medical sources of recommendation or information had contributed to their decision to avoid dairy; and to identify any formally diagnosed condition that required them to avoid dairy.

Other sections of the survey provided the following measures. Neuroticism, a personality dimension characterised by anxiety and negative emotions, was measured with nine items from the NEO-N Domain[6]. Participants rated statements (e.g. 'I panic easily') on a 5-point scale, where 1 = 'completely false' and 5 = 'completely true'. Reasoning style was assessed by the Rational-Experiential Inventory (REI)[7], comprising five items drawn from each of the Need for Cognition[8] and Faith in Intuition Scales[7], each item employing a 5-point scale from 'completely false' to 'completely true'. Higher scores represent increased reliance on analytical and intuitive reasoning for each scale, respectively.

In a section addressing general health, participants were asked to identify past diagnoses from a list of twelve conditions. Illness worry was measured with four items from the Whitely Index for the assessment of hypochondriasis (e.g. 'Do you often worry about the possibility that you have got a serious illness?')[9]. Receptiveness to conventional medicine (four items) and complementary medicine (six items) were assessed by ratings of the likelihood of taking certain actions for health matters (e.g. 'Consult a doctor', 'Consult a naturopath'). Responses were measured on a scale from 1 = 'definitely not' to 7 = 'definitely'.

Statistical analyses

Prior to analyses, the pattern of missing data for the continuous variables was investigated with the Missing Values Analysis module in the statistical software package IBM SPSS Statistics version 20·0. Little's MCAR test[10] showed that the data were missing completely at random ($\chi^2 = 28701·40$, df = 28818, $P = 0·69$); consequently, missing values were imputed using the EM (expectation maximization) algorithm. Descriptive statistics were calculated to provide frequency distributions and

cross-tabulations of key variables. The χ^2 test of independence and Fisher's exact test, as appropriate[11], were used to examine associations between categorical variables. Predictors of avoidance were assessed by means of multivariable logistic regression. Pearson point-biserial correlations were calculated for bivariate associations between continuous and dichotomous variables, and group differences in ratings of sources of influence were assessed with one-way ANOVA. IBM SPSS Statistics versions 20·0–22·0 were used for all analyses.

Results

Preliminary analyses

Of the 1184 participants who returned the completed questionnaires, 188 (unweighted 15·9%, weighted 16·6% of the sample) indicated that they were currently avoiding dairy products (seventy men, 115 women and three of undisclosed gender). Of this number, fifteen (1·3% unweighted, 1·2% weighted) reported avoiding dairy products because of a medically diagnosed condition, mostly cardiovascular, and thirty-four (2·9% unweighted, 2·8% weighted) gave diverse reasons unrelated to symptoms or diagnosed conditions. Explanations given included: concerns about levels of saturated fat; personal dislike of taste; calorie and weight management; and the view that dairy foods were not appropriate for human adult consumption.

The remaining 139 (11·7% unweighted, 12·6% weighted) reported symptoms and negative reactions to the consumption of dairy products, including nine people (0·8%) who reported having been formally diagnosed with coeliac disease. All subsequent analyses focused on the remaining 130 (11·0% unweighted, 11·8% weighted) symptomatic dairy avoiders: eighty-two (63·1%) women, forty-five (34·6%) men and three (2·3%) of unknown gender.

Main analyses

Of this symptomatic dairy-avoiding group, seventy-eight (60·0%) nominated physical reactions as their main reason for avoiding dairy foods, twenty-five (19·2%) nominated intolerance or allergy, five (3·9%) gave various other reasons and twenty-two (16·9%) gave no reason. Partial dairy avoidance (n 98; 75·4%) was reported more frequently than full avoidance (n 29; 22·3%). The foods most commonly nominated by partial avoiders were milk (55·4%), cheese (16·9%) and cream (16·2%).

Thirty (23·1%) symptomatic dairy avoiders reported having a formal diagnosis that required them to avoid dairy. The diagnoses were reported as lactose intolerance (n 5; 3·8%), high cholesterol (n 6; 4·6%), asthma (n 4; 3·1%), allergy (n 3; 2·3%), IBS (n 3; 2·3%), diabetes (n 2; 1·5%) and several unique responses.

Symptoms reported

The most commonly reported reactions involved gastrointestinal discomfort, with 62·3% indicating either 'stomach discomfort or cramps' or 'bloating or wind'; also common were diarrhoea and mucus build-up. Table 1 lists the frequency of occurrence of all eighteen symptoms; these did not differ significantly between self-reported complete and partial avoiders.

The cross-tabulation of dairy avoidance with wheat avoidance data identified forty-five symptomatic wheat avoiders (SWA; 3·8% unweighted, 3·5% weighted), eighty-eight symptomatic dairy avoiders (SDA; 7·4% unweighted, 8·2% weighted) and forty-two symptomatic wheat-and-dairy avoiders (SWDA; 3·6%), the latter representing 32·3% of the 130 symptomatic dairy avoiders. Figure 1 summarises the classification of participants. Table 2 reports a comparison of categories of symptoms attributed to wheat and dairy by avoiders of either, but not both. Relative to wheat, dairy was less frequently associated with gastrointestinal symptoms ($\chi^2 = 5·94$, $P = 0·015$) and tiredness ($\chi^2 = 7·68$, $P = 0·006$) and more frequently associated with mucus production ($\chi^2 = 13·61$, $P < 0·001$). Further comparisons showed that wheat-and-dairy avoiders were more likely than wheat avoiders to attribute mucus production (23·8%; $\chi^2 = 9·17$, $P = 0·007$) to wheat and more likely than dairy avoiders to attribute tiredness (31·0%; $\chi^2 = 8·69$, $P = 0·007$) and skin problems or hives (23·8%; $\chi^2 = 9·15$, $P = 0·004$) to dairy. There were no other group differences.

Table 3 shows the results of multivariable logistic regression for the prediction of membership of the three avoidance categories relative to the rest of the sample (n 994), coeliac cases excluded. Symptomatic wheat

Table 1 Frequency and type of symptoms reported by symptomatic dairy avoiders (n 130); CSIRO Food and Health Survey, Australia, December 2010–February 2011

| Reported symptoms	Total	
	n	%
Stomach discomfort or cramps	66	50·8
Bloating or wind	57	43·8
Diarrhoea	48	36·9
Mucus build-up	46	35·4
Feeling sluggish or tired	22	16·9
Vomiting or nausea	21	16·2
Constipation	19	14·6
Heartburn or indigestion	18	13·8
Skin problems	15	11·5
Sleep disturbance	13	10·0
Headaches	13	10·0
Breathing problems	7	5·4
Body aches and pains	7	5·4
Feeling anxious or irritable	4	3·1
Sweating	4	3·1
Hives	4	3·1
Feeling restless or hyperactive	1	0·8
Feeling sad or blue	0	0·0

Multiple responses were allowed.
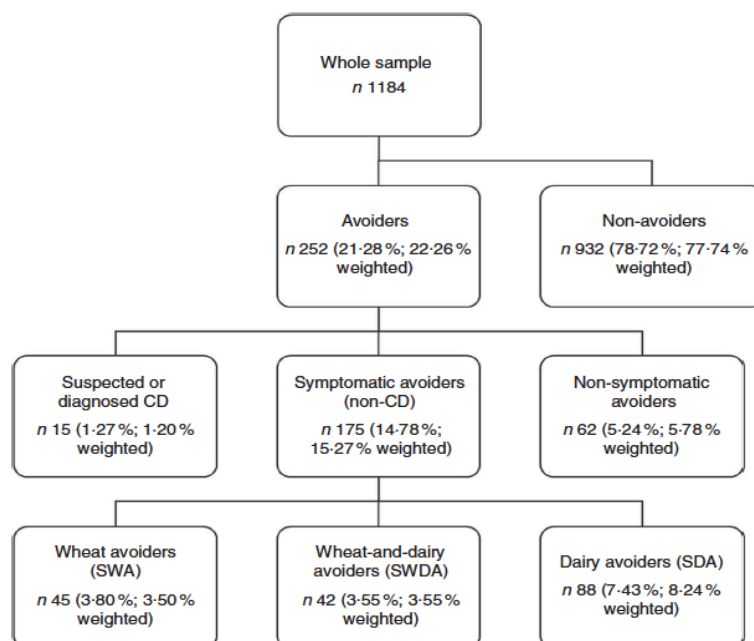
Fig. 1 Flowchart of the classification of self-reported avoiders of dairy products and wheat products; CSIRO Food and Health Survey, Australia, December 2010–February 2011 (CD, coelic disease)

Table 2 Summary of symptoms reported by avoiders of wheat (n 45) and dairy (n 88); CSIRO Food and Health Survey, Australia, December 2010–February 2011

Reported symptoms	Wheat avoiders		Dairy avoiders	
	n	%	n	%
Gastrointestinal*	43	95·6	68	77·3
Nausea and vomiting	3	6·7	12	13·6
Skin problems or hives	5	11·1	5	5·7
Breathing problems	1	2·2	4	4·5
Sweating	2	4·4	3	3·4
Head or body aches	6	13·3	11	12·5
Behavioural	9	20·0	11	12·5
Mucus**	1	2·2	28	31·8
Sluggish or tired*	14	31·1	9	10·2

Gastrointestinal = stomach discomfort or cramps; bloating or wind; diarrhoea; constipation; or heartburn or indigestion.
Behavioural = feeling anxious or irritable; feeling restless or hyperactive; or feeling sad or blue.
Significant difference in frequency of reported symptom by group: *$P < 0.05$, **$P < 0.001$.

avoidance was significantly predicted by gender (being female) and receptiveness to complementary medicine. A negative association with receptiveness to conventional medicine approached statistical significance. Symptomatic avoidance of both wheat and dairy products was similarly predicted by being female, more receptive to complementary medicine and less receptive to conventional medicine. Symptomatic dairy avoidance was significantly

predicted by age (negatively) and worry about illness. Follow-up Pearson point-biserial correlations revealed no significant associations between illness worry and a particular symptom or symptoms.

Table 4 shows the frequencies of past diagnoses reported by members of the three groups of avoiders relative to the rest of the (non-coeliac) sample. For each of the avoidance categories, membership was associated with increased reporting of a past diagnosis of food intolerance or allergy; for the SDA group, it was also associated with more reports of IBS and of chronic fatigue syndrome and for the SWDA group, with more reports of IBS and of depression.

One-way ANOVA were conducted to compare the ratings by the three avoidance groups of possible sources of influence on the decision to avoid. The sources of influence were defined as Medical (mean of Doctor and Other Specialist ratings), Complementary Medicine (mean of Naturopath and Other Complementary Medicine ratings), Family and Friends, and Media (mean of Internet and Media ratings). For the SWDA group, who completed influence ratings for both wheat avoidance and dairy avoidance, scores were further calculated as the mean of those ratings. Results showed a significant group difference for Complementary Medicine ($F (2,157) = 6.06$, $P = 0.003$); Tukey post hoc comparisons indicated that rated influence of complementary medicine sources

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Table 3 Multivariable logistic regression of predictors of symptomatic wheat avoidance, symptomatic dairy avoidance and symptomatic wheat-and-dairy avoidance; CSIRO Food and Health Survey, Australia, December 2010–February 2011

						95 % CI for OR	
Predictor	β	SE	Wald	P	OR	Lower	Upper
SWA *v.* rest of the sample							
Receptiveness to complementary medicine	0·49	0·16	9·14	0·002	1·64	1·19	2·26
Gender	−1·36	0·41	11·17	0·001	0·26	0·12	0·57
Receptiveness to conventional medicine	−0·29	0·15	3·73	0·053	0·75	0·56	1·00
Age	0·01	0·01	0·94	0·333	1·01	0·99	1·03
Analytical thinking style	0·22	0·21	1·09	0·297	1·24	0·83	1·88
Intuitive thinking style	0·13	0·23	0·32	0·575	1·14	0·73	1·77
Neuroticism	−0·40	0·28	2·11	0·147	0·67	0·39	1·15
Illness worry	0·09	0·20	0·19	0·662	1·09	0·73	1·63
SDA *v.* rest of the sample							
Receptiveness to complementary medicine	0·12	0·12	1·13	0·288	1·13	0·90	1·42
Gender	−0·09	0·24	0·16	0·692	0·91	0·57	1·45
Receptiveness to conventional medicine	−0·08	0·12	0·42	0·519	0·93	0·73	1·17
Age	−0·02	0·01	5·99	0·014	0·98	0·97	0·99
Analytical thinking style	0·09	0·15	0·33	0·568	1·09	0·81	1·47
Intuitive thinking style	−0·13	0·16	0·64	0·423	0·88	0·65	1·20
Neuroticism	0·05	0·18	0·07	0·799	1·05	0·74	1·49
Illness worry	0·30	0·14	4·78	0·029	1·35	1·03	1·78
SWDA *v.* rest of the sample							
Receptiveness to complementary medicine	0·48	0·17	8·21	0·004	1·62	1·16	2·25
Gender	−1·30	0·42	9·72	0·002	0·27	0·12	0·62
Receptiveness to conventional medicine	−0·62	0·14	18·52	0·000	0·54	0·41	0·71
Age	0·01	0·01	0·89	0·345	1·01	0·99	1·03
Analytical thinking style	0·40	0·22	3·30	0·069	1·49	0·97	2·30
Intuitive thinking style	0·07	0·23	0·10	0·753	1·08	0·69	1·69
Neuroticism	−0·03	0·27	0·02	0·901	0·97	0·57	1·65
Illness worry	0·30	0·21	2·10	0·147	1·35	0·90	2·01

Model $\chi^2 = 90\cdot42$, $P < 0\cdot001$; n 1184.
Analyses involved a four-level classification of the sample as symptomatic wheat avoiders (SWA), symptomatic dairy avoiders (SDA), symptomatic wheat-and-dairy avoiders (SWDA) and the rest of the sample with cases of coeliac disease excluded.

Table 4 Diagnosed conditions reported by symptomatic dairy avoiders (SDA), symptomatic wheat avoiders (SWA), symptomatic wheat-and-dairy avoiders (SWDA) and the rest of the sample with cases of coeliac disease excluded; CSIRO Food and Health Survey, Australia, December 2010–February 2011

	SDA		SWA		SWDA		Rest of the sample	
Reported diagnosed condition	*n*	%	*n*	%	*n*	%	*n*	%
Heart disease and/or stroke	5	6·0	5	11·6	5	12·5	114	11·8
Diabetes	6	7·1	3	7·0	2	5·0	63	6·5
Obesity	10	12·2	4	9·8	2	5·1	96	10·0
Bowel or colorectal cancer	1	1·2	0	0·0	1	2·5	22	2·3
Irritable bowel syndrome	13*	15·3	7	16·7	10**	26·3	78	8·1
Inflammatory bowel disease	4	4·7	2	4·7	3	7·7	24	2·5
Chronic fatigue syndrome	7*	8·2	2	4·7	2	5·1	22	2·3
Asthma	14	16·5	11	25·6	9	22·5	166	17·4
Depression	23	27·1	12	27·9	15*	38·5	180	18·8
Food sensitivity or allergy	33**	37·5	16*	35·6	17**	40·5	79	7·9

*χ^2 significant at <0·05 level, **χ^2 significant at <0·001 level.

was significantly lower for the SDA group (mean = 1·31, SD = 0·54) than for the SWDA group (mean = 1·74, SD = 0·76) but not the SWA group (mean = 1·46, SD = 0·63).

Discussion

The survey data indicate that a substantial number of the Australian adult population are avoiding dairy foods.

At 16·6 % (population-weighted by age and gender), the prevalence of dairy avoidance reported is 55 % greater than was observed for wheat[5]. The explanations provided for the behaviour include various idiosyncratic factors (2·8 %), management of several (mainly cardiovascular) diagnosed medical conditions (1·2 %) and coeliac disease (0·8 %). However, of most interest here is the remaining 11·8 % of the sample who attributed symptoms and negative reactions to the consumption of

dairy foods. Almost a third (3·6 %) of this symptomatic group also reported avoiding wheat products for alleviation of symptoms. Together with wheat-only (3·5 %) and dairy-only (8·2 %) avoiders, they put the combined prevalence of (ostensibly non-coeliac) symptomatic avoiders of either dietary factor at 15·3 %.

Symptoms, diagnoses and the potential for misattributions

Milk and wheat both contain components that can trigger adverse serious physiological reactions. Principally, these components are a disaccharide (lactose) and protein (gluten), respectively, and the intolerances that they trigger are diagnosed clinically. However, the avoidance of dairy foods for symptom control, as found previously for wheat[5], appeared to rely substantially on a non-medically diagnosed connection between ingestion and symptoms. Reports of a diagnosed allergy or intolerance mandating the avoidance were similarly infrequent at 6·2 % (0·7 % of the sample). Avoiders of dairy foods cited gastrointestinal symptoms most commonly, although less consistently than was the case for wheat products. Fatigue was also cited less frequently and mucus build-up considerably more frequently for dairy than for wheat. Dairy products have often been blamed for increased oral and nasal mucus production, but these effects have not been substantiated by well-controlled studies[12,13].

Although it would be unwise to attempt diagnoses on the basis of the present data, the symptoms claimed for dairy admit the possibility of undiagnosed dairy allergy or lactose intolerance. IBS-like symptoms may also reflect the involvement of poorly absorbed short-chain carbohydrates, other than lactose, which can induce gastrointestinal discomfort through osmotic effects or rapid fermentation by the colonic microbiota. These carbohydrates (FODMAPS: fermentable oligo-saccharides, disaccharides (lactose), monosaccharides (fructose) and polyols)[14,15] may be present in dairy products or in foods consumed with dairy products, and effects may be independent of or additive with lactose[16].

Reports of past diagnoses elicited independently of the question of food avoidance do not clarify the picture greatly. Symptomatic avoiders of dairy, wheat or both often reported having at some time been diagnosed with a food intolerance or allergy despite the dearth of such reports specific to the avoidance behaviour. Unsurprisingly, reports of a previous diagnosis of IBS were also common. Dairy avoiders were also more likely than the average to report a past diagnosis of chronic fatigue syndrome, although the numbers involved were still small. It has been proposed that a co-morbid triad of perceived food intolerance, IBS and fatigue might point to a common underlying cause[17]; however, a causal relationship between these conditions has not been ascertained. Causation is also unclear in the greater likelihood for dairy

avoiders who also avoided wheat to report a past diagnosis of depression.

Whatever the causal agents and physiological factors that trigger the avoidance of dairy foods, the general lack of a formal diagnosis – reasons for which may range from negative test results to an absence of medical involvement – is a matter of serious public health concern. It has been proposed that health-care professionals may recommend avoidance of dairy foods as a viable treatment option when they feel that they have little else to offer patients[18]. Self-diagnosed links between a dietary component and symptoms may derive from adverse publicity either directly or as a manifestation of categorical thinking about some foods as being intrinsically bad[19]. Although consumers may find justification for a dietary strategy in an apparent reduction in symptoms, confidence may be misplaced[20]. Non-specific gastrointestinal symptoms often attributed to intolerance have been found to be susceptible to the placebo effect associated with dietary manipulations[21–24]. In short, the potential for misattribution of an underlying symptomatic state is clearly considerable.

Two populations of avoiders?

The similarities in symptoms and frequent co-occurrence of dairy avoidance and wheat avoidance prompt the question whether they are fundamentally two expressions of a single phenomenon. However, the different predictive profiles broadly suggest two avoidant populations: the one avoiding wheat and possibly also dairy foods and another avoiding dairy but not wheat foods. They also depict the two types of avoidance as substantially different psychosocial phenomena, with dairy avoidance tending to be associated with an internal focus on the possibility of illness rather than the external focus on treatment strategies evident in wheat avoidance.

Worry about illness may represent a position on a continuum of health anxiety of which hypochondriasis is an extreme and rare form[25–28]. Concerns about the possibility of illness may be also be reactive, being provoked by perceived unusual changes in bodily functioning, exposure to negative information about health that is personally significant, or (perhaps less plausibly here, given the null finding for neuroticism) bodily sensations that are catastrophically interpreted[29]. What cannot be determined, therefore, is to what degree dairy avoidance is the behaviour of a more symptom-vigilant population[30] or associated with more severe or distressing symptoms[31]. This is an important distinction and a question for further research.

Strengths, limitations and public health implications

As discussed previously[5], the strengths of these survey data lie in the use of probability sampling from the

national adult population and the potential contributions of response anonymity and structure of the omnibus survey to limiting of response biases. Conversely, weaknesses include the inability to substantiate participants' reports, to examine possible differences in dairy avoidance by race or ethnicity, or to quantify any possible sampling bias associated with interest in food or health. If these data are representative, they document symptom-related avoidance of wheat or dairy products by one in seven Australian adults of voting age. Not included in this estimate are those further adults (estimated at 5·8 %) with symptom-unrelated explanations for their avoidance, other household members exposed to these dietary strategies and children. Even if the survey figures should overestimate prevalence, they testify to a significant public health phenomenon in the self-prescribed avoidance of dietary factors.

The self-prescribed nature of symptom-related dairy (and wheat) avoidance inevitably raises concerns about the rigour and accuracy of the diagnostic process and the risk of serious health conditions going undetected. A more serious issue arises if the elimination of a dietary factor is naively assumed to be intrinsically health-enhancing without compensatory replacement of sources of the missing nutrients. Irrespective of whether or not individuals are correct in identifying dairy products as the cause of their symptoms, we then have the paradoxical prospect of a health-motivated reduction in dairy consumption increasing risk of a condition like osteoporosis. Moreover, the volitional nature of a self-prescribed intervention lends it an added psychological potency. With a sense of autonomy come enhanced ownership of, adherence to and consequently outcomes of a health intervention[32,33]. In the present case, this can be expected to increase also the likelihood of any adverse consequences.

Future directions

Clearly, these survey findings warrant follow-up investigation to determine both the decision processes leading symptomatic individuals to avoid dairy consumption and the impact on resultant nutritional status. Given the potential numbers of Australians involved, it is important to establish whether increased level of worry about illness is antecedent to or a response to symptoms. The latter suggests that symptom severity may be a factor. Whether the attribution of symptoms to dairy is accurate is a matter for clinical investigation. However, the process is further complicated in the case of people who are also avoiding wheat products. Further questions for investigation include what other self-prescribed dietary changes consumers may be practising, whether in response to symptoms or the perception that such behaviour is intrinsically health-promoting. It is also noteworthy that few avoiders of dairy invoked lactose in explaining their behaviour. This cautions against the conclusion that the behaviour observed here substantially explains the market for lactose-free products; a similar point was made in respect of wheat avoidance and the gluten-free market[5]. Nor should the behaviour be interpreted as evidence of self-diagnosed food intolerances, which have been the topic of much discussion in recent decades[34–36]. A perceived intolerance is a particular attribution of a symptomatic state and may thus represent the response of a subset only of those who avoid a dietary factor because of symptoms they associate with its consumption. It is the avoidance that especially demands systematic investigation.

Conclusions

In addition to the many adult Australians avoiding consumption of wheat or both wheat and dairy products, a similar further number reports avoiding dairy products, similarly mostly without a formal diagnosis, and citing largely similar, primarily gastrointestinal, symptoms. The accuracy of self-diagnoses, the actual sources of symptoms and the physiological mechanisms remain to be established; in addition, the tendency for dairy avoidance to be associated with more worry about illness identifies both symptom severity and psychological responses to symptoms attributed to dairy as targets for further investigation. Most significantly, though, the findings are further evidence of a widespread tendency for people to seek to exercise control over their health by eliminating dietary factors considered suspect without medical evidence or oversight. Avoiding foods to alleviate adverse symptoms should be weighed against the consequences of eliminating dietary factors and their related nutrient profiles. In the case of dairy foods, those consequences could be significant for individuals and, given the apparent scale of the avoidance behaviour, for society in the long term.

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