EXPLORING THE USE OF DIET AND SUPPORT NEEDS OF PEOPLE LIVING WITH PSORIASIS

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ABSTRACT

Background

Psoriasis is a chronic immune-mediated skin condition affecting approximately 60 million people globally. It is associated with substantial comorbidities, and while lifestyle factors may help manage psoriasis, research on the use and effectiveness of diet remains limited, particularly in the UK. With approximately 2% of adults living with psoriasis in the UK, this represents an important knowledge gap. This thesis aims to explore the role of diet in psoriasis management, to enhance our understanding of how to support people living with psoriasis (PLwP) in the UK.

Methods

A mixed-methods sequential design was used, and 4 studies were undertaken. Firstly, a scoping review was conducted to provide a comprehensive overview of the current evidence. To explore the dietary experiences of PLwP in the UK both qualitative and quantitative methods were utilised. Given the limited research thematic analysis of qualitative interviews was conducted to gain initial insights into the dietary modifications and experiences of PLwP in the UK. Based on these findings, a cross-sectional questionnaire was developed to quantitively explore the dietary modifications, skin responses, patient experiences, and information acquisition, among a larger population. The data from the first 3 studies informed the development of a dietary support guide for PLwP utilising a user-centered design (UCD) approach, incorporating think aloud methodology; its usability was evaluated using the System Usability Scale.

Results

The scoping review revealed that randomized control trials (RCTs) support low-calorie diets for those living with overweight or obesity and gluten-free diets for those with coeliac disease, to improve psoriasis. Further evidence is limited, and patient information rarely provides dietary support. Research on dietary use and experiences of PLwP has not been explored in the UK. Interviews with PLwP in the UK (n=9) revealed that most believed diet

affected their psoriasis and tried restrictive diets, with limited success. Participants commonly sought dietary information online due to perceived lack of support from healthcare professionals (HCPs). The subsequent cross-sectional questionnaire (n=271) revealed that 47.2% of PLwP reported making a dietary modification to help their psoriasis. Common restrictions included high-sugar foods (64.1%) and dairy (63.3%). Participants with severe psoriasis (OR 2.268; p=0.027), aged 18-44 (OR 2.050; p=0.007), psoriatic arthritis (OR 2.754; p=0.003), or gluten sensitivity (OR 3.579; p=0.004) were more likely to have tried a dietary modification compared to those without these characteristics. Most (61.3%) changed their diet to also improve overall health, and (53.6%) wanted more dietary support. The dietary support guide was developed with an expert panel (n=7), and intended users (n=7). The final guide was evaluated as having good usability and was perceived to be useful and valuable by intended users (n=27).

Conclusion

Dietary modification is common among PLwP in the UK, primarily motivated by a desire to improve psoriasis and overall health. However, the majority of dietary modifications undertaken are unsubstantiated and restrictive. There is a need and desire for dietary support for PLwP. This thesis makes a notable contribution to patient-centred psoriasis care by directly addressing the identified dietary support gap, through the development of an evidence-based dietary support guide for PLwP. The involvement of PLwP and stakeholders in the development ensured it was usable and valuable to PLwP. Future research should assess the use and impact of the dietary support guide, and its value to HCPs. Additionally, larger, long-term studies to explore the impact of diet on psoriasis, and exploration of how nutritional support can be integrated into psoriasis care is needed.

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LIST OF PUBLICATIONS, PRESENTATIONS AND AWARDS

Publications:

Hawkins P, Earl K, Tektonidis TG, and Fallaize R. The role of diet in the management of psoriasis: a scoping review. Nutrition Research Reviews. Published online 202;1-35. doi:10.1017/S0954422423000185

Hawkins P, Mason S, Earl K, Tektonidis TG, and Fallaize R. Qualitative exploration of the experiences and perceptions of diet in psoriasis management among UK adults. BMJ Open. 2025;15:e085536. doi:10.1136/ bmjopen-2024-085536

Cowan S, **Hawkins P,** Marks G, and Fallaize R. Diet and Psoriasis-Related Information on Instagram: A Quality and Content Analysis of Posts Under Popular Psoriasis Hashtags. Journal of Human Nutrition and Dietetics. 2025;38:e70034. doi.org/10.1111/jhn.70034

Presentations:

School of Life and Medical Sciences Conference, University of Hertfordshire, 2022: Exploring the role of diet in the management of psoriasis: dietary behaviours, perceptions and self-reported skin outcomes of people with psoriasis. *Winner of best oral presentation competition*.

School of Life and Medical Sciences Conference, University of Hertfordshire, 2023: Exploring the use of diet in the management of psoriasis in adults in the UK.

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The Nutrition Society Summer Congress, Belfast 2024: A nutritional navigation guide for people with psoriasis: a user-centred design approach.

ABBREVIATIONS

Abbreviation	Definition
AD	Atopic dermatitis
AMP	Antimicrobial peptides
APC	Antigen presenting cell
BMI	Body mass index
BSA	Body surface area
CAM	Complementary and alternative medicines
CLCI	Cumulative life course impairment
CRP	C-reactive protein
CTA	Concurrent think aloud
CVD	Cardiovascular disease
DC	Dendritic cell
DHA	Docosahexaenoic acid
DLQI	Dermatology life quality index
EP	Expert panel
EPA	Eicosapentaenoic acid
EVOO	Extra virgin olive oil
FFQ	Food frequency questionnaire
FKGL	Flesch Kincaid grade level
FRE	Flesch reading ease
GFD	Gluten Free diet
GP	General practitioner
GWAS	Genome wide association studies
HCP	Healthcare professionals

HFD	High fat diets
HLA	human leukocyte antigen
HSF	High sugar foods
IBD	Irritable bowel disease
IF	Intermittent fasting
IFN	Interferon
IL	Interleukin
IMID	Immune mediated inflammatory disease
JBI	Joanna Briggs Institute
LCD	Low calorie diet
MD	Mediterranean diet
MHC	major histocompatibility complex
MND	Micronutrient deficiencies
MUFA	Monounsaturated fatty acids
NF-kB	Nuclear factor kappa-B
NHS	National Health Service
NPF	National psoriasis foundation
OR	Odds ratio
PAMP	Pathogen-associated molecular pattern
PAPAA	Psoriatic and Psoriatic Arthritis Alliance
PASI	Psoriasis area and severity index
PLwP	People living with psoriasis
PPIE	Public and patient involvement and engagement
PUFA	Polyunsaturated fatty acids
QoL	Quality of life
RCT	Randomised control trial
SMOG	Simple measure of gobbledygook

SNP	Single nucleotide polymorphism
SUS	System usability survey
TNF	Tumer necrosis factor
Tregs	T regulatory cells
UCD	User-centred design
UK	United Kingdom
UVB	Ultraviolet B
VLCKD	Very low-calorie ketogenic diet
WHO	World Health Organization

CHAPTER 1 BACKGROUND AND THESIS OVERVIEW

CHAPTER SUMMARY

In this chapter I present an overview of the relevant background literature for this thesis. I start by summarising the fundamentals of human skin, immunology and immune mediated inflammatory diseases, followed by an overview of psoriasis. I then discuss existing literature on lifestyle management of psoriasis, highlighting the limitations and research gaps in this area. This chapter also outlines the aim and objectives of the PhD, detailing the overall thesis structure. Information on the patient and public involvement and engagement, the utilisation of mixed methods, and contributions to this thesis are also provided.

1.1 THE SKIN

Human skin is a complex immunologic organ, which serves a multifaceted role. It is the largest organ of the body and acts as a protective layer between the external and internal environment, not only as a physical barrier but also as a primary site of immunological defence (1,2). The skin is made up of three primary layers, the epidermis, the dermis, and the hypodermis (**Figure 1.**).

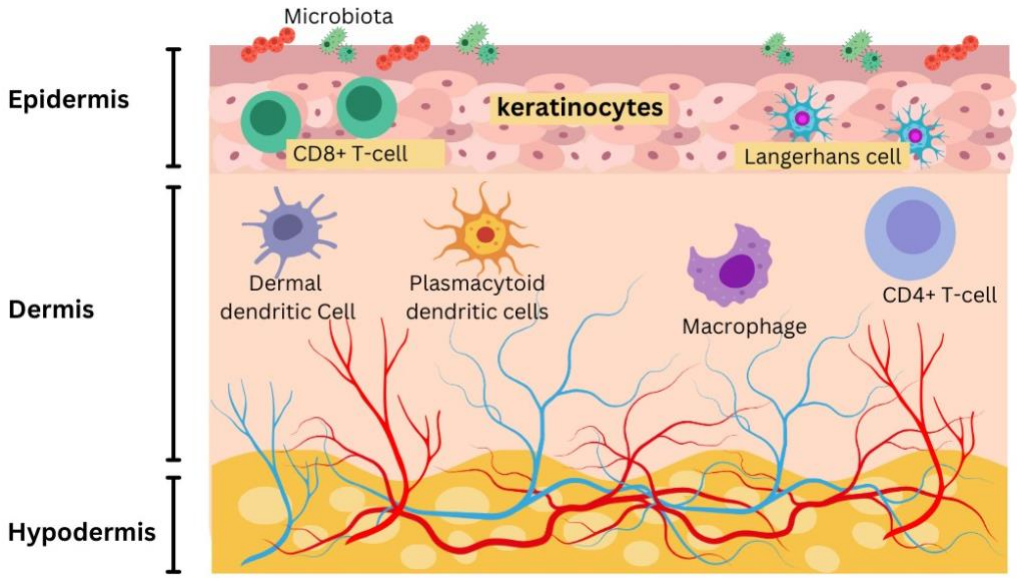

Figure 1. A diagrammatic cross-section of human skin showing the three primary layers, and key immune cells. Produced using information from Zhang et al. 2022 (3) and Nestle et al. 2009 (4)

The epidermis is the outermost layer of the skin, and on its surface supports an epidermal microbiome with diverse populations of microbiota, which can influence cutaneous immunity in the host (5,6). Through the production of metabolites that inhibit the growth of pathogens on the skin and in educating the cutaneous immune system (5,7–9). Keratinocytes are the predominant cell type in the epidermis, which produce keratin, the major building blocks of the epidermis (2). Keratinocytes proliferate in the deepest layer of the epidermis (the basal layer) and start to differentiate as they migrate to the skin surface, where they replace the cells that have been shed, to restore the surface layer of tightly

packed cells, of the epidermis (10,11). In healthy skin the proliferation of keratinocytes matches the rate of loss on the surface of the skin, to ensure epidermal thickness is constant (10). This process is controlled by epigenetic factors (11). As well as providing structure, and a barrier to the external environment, keratinocytes also play a role in regulating the immune response of the skin (12,13) by producing antimicrobial peptides (AMPs). These regulate the resident microorganisms and express toll-like receptors which when stimulated activate the nuclear factor kappa-B (NF-kB) signalling pathway to induce the expression of inflammatory cytokines and chemokines (12,13). Through the secretion of these, keratinocytes can regulate, recruit and activate immune cells (1,2,13,14). The epidermis also contains Langerhans cells, which are antigen-presenting cells that play a pivotal role in activating an immune response in the presence of pathogens (2). The epidermis is avascular and relies on the vascular network of the dermis for oxygen, nutrients and waste product removal (1).

The dermis is the second layer of the skin, lying beneath the epidermis. It is composed primarily of collagen and elastin fibres which maintain skin structure integrity (2,15). It also houses a network of blood and lymphatic vessels, sweat and sebaceous glands, hair follicles and nerve endings (2,6,10). The vascular network sustains and supports the epidermis and assists in thermoregulation (2,10). The dermis is also immunologically active and houses multiple immune cells, including macrophages, dendritic cells (DCs), neutrophils, natural killer cells, mast cells, T cells and regulatory T cells (Tregs) (1,14). The hypodermis lies under the dermis. It is largely made-up of adipocytes that provide an insulating and protective layer of subcutaneous fat which is interwoven with blood vessels and nerves (1,2,14).

1.2 THE IMMUNE SYSTEM

The Immune system is a complex network of cells, chemicals and pathways that work to protect the body from a range of pathogens, including bacteria, parasites, viruses, cancer cells and toxins (16,17). It is separated into two components, innate immunity and adaptive immunity. Although the innate and adaptive immune systems possess distinct

characteristics and functions, they are deeply interconnected systems that work synergistically to protect and maintain the physiological homeostasis of the host (16,17) (**Figure 2**.). Defects in either system can lead to host vulnerability or inappropriate immune responses (18–20).

1.2.1 Innate Immunity

Innate immunity is the body's first line of protection against pathogens (16). It is a rapid, non-specific defence mechanism implemented by the host immediately upon encountering an antigen (16). The innate immune system is comprised of physical anatomical barriers (e.g., the skin and mucous membranes), physiological defensives (e.g., temperature and pH) alongside inflammation and immune cell responses (3,16).

The innate immune system has no immunological memory and therefore relies on pattern recognition receptors (PRRs). These allow certain immune cells to rapidly identify and respond to molecular structures shared broadly by pathogens, known as pathogen associated molecular patterns (PAMPs) (16,17). Once a pathogen is identified, the innate immune system rapidly produces cytokines and chemokines, proteins that are involved in cell-to-cell communication (21,22) which play a key role in mobilising the immune response (16,22). Key proinflammatory cytokines, such as tumour necrosis factor α (TNF-α), interleukin (IL) -6, IL-12, and IL-23, are primarily secreted by macrophages and dendritic cells and activate the immune system by recruiting immune cells to sites of infection and initiating and sustaining inflammatory responses (23). Dysregulated production of these inflammatory cytokines is often associated with inflammatory or autoimmune diseases, making them important therapeutic targets (16,21,22,24). A further function of the innate immune system is to stimulate the adaptive immune system via activation of antigen presenting cells (APCs) (16).

1.2.2 Adaptive Immunity

The adaptive immune system is aided by innate immunity and becomes crucial when innate immunity cannot eliminate pathogens (16,24). Adaptive immunity recognises

specific "non-self" antigens, generates effector pathways to eliminate pathogens or infected cells, and develops memory for rapid future responses (16). It is the foundation of immunisation against infectious diseases. Adaptive immunity consists of antigen-specific T cells activated by APCs and B cells that produce antibodies**.** Due to the interconnectedness of both the innate and adaptive immune systems (**Figure 2**.), defects or alterations in either system can lead to dysregulated immune responses and feed into inflammatory and autoimmune disease pathogenesis (1,22,24).

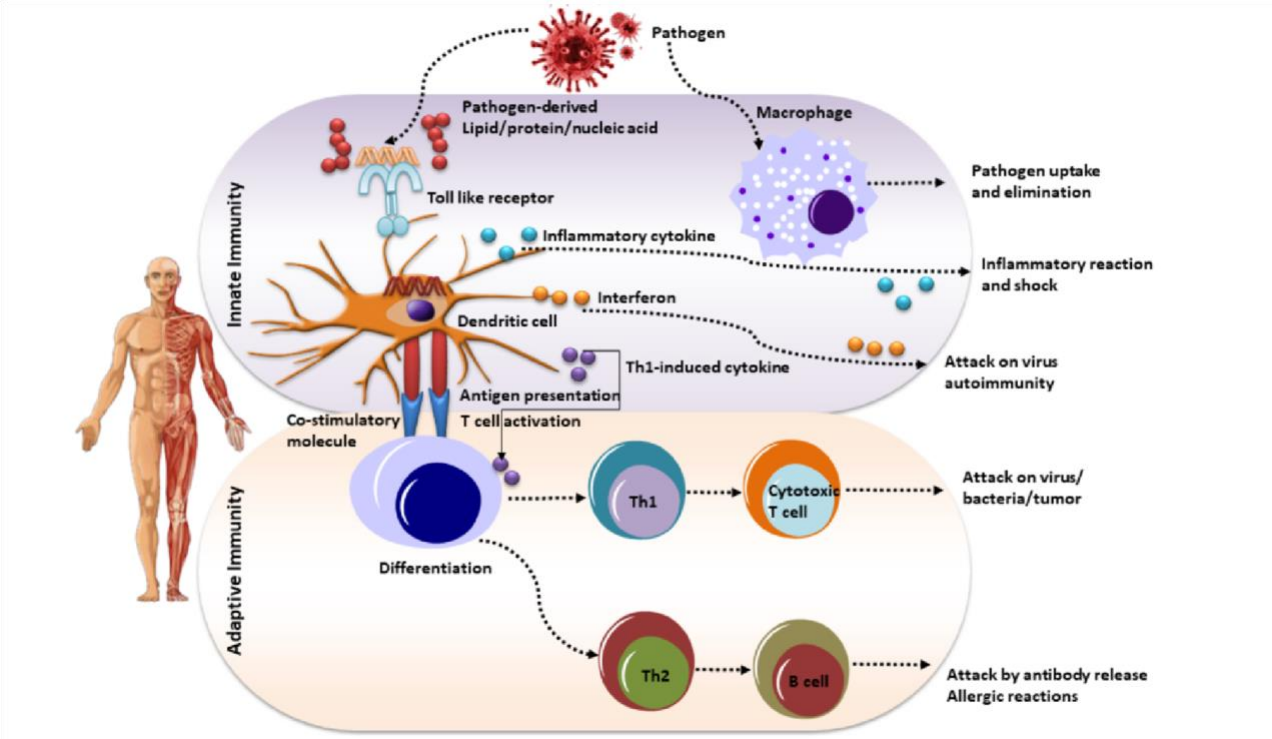

Figure 2. A diagrammatic overview of the interaction between the innate and adaptive immune systems taken from Patra, 2018 (25).

Once activated the immune system continues to produce proinflammatory cytokines if the stimulus persists. The production of proinflammatory cytokines is tightly regulated by various mechanisms to prevent excessive inflammation and tissue damage (22). This includes the secretion of anti-inflammatory cytokines which modulate immune responses and limit excessive inflammation by inhibiting pro-inflammatory pathways and regulating immune cell activity (23,26). While cytokines are vital components of the immune system that facilitate host defence and immunological homeostasis (16), abnormal cytokine

production including overproduction, alteration or dysregulation can lead to system dysfunction and excessive inflammation (1,21,22,24,27). This promotes various immune-mediated inflammatory disease (IMID) pathologies, including inflammatory skin diseases (1,24,27,28).

1.3 IMMUNE MEDIATED INFLAMMATORY DISEASES

Immune-mediated inflammatory diseases (IMIDs) are a group of diverse diseases characterised by dysregulation of the immune system that leads to chronic inflammation of specific organs and tissues. This often extends beyond local inflammation and has systemic effects as well (28–31). Although many IMIDs share common underlying pathogenic mechanisms, genetic susceptibility, and environmental stimuli, each disease often has unique immune pathways and key disease-specific cytokine profiles (28,29). For example, psoriasis and atopic dermatitis (AD) are both T-cell mediated inflammatory diseases which affect the skin, yet psoriasis is primarily driven by Th17 T-cells and IL-17 activation, and AD by Th2 and associated IL-4 and IL-13 over-production (32). Psoriasis and psoriatic arthritis responds to inhibition of IL-17A and IL-23, yet rheumatoid arthritis does not, indicating that the cytokine profiles are similar in psoriatic disease (28).

IMIDs are common, affecting between 5%-7% of the population in Western countries (33), with an increasing incidence observed in both Western populations and other regions in recent years (30,34,35). IMIDs can have a substantial negative impact on health and quality of life (QoL) for those affected due the chronic nature of the diseases, health impacts, symptoms and long-term treatment needed (36,37). They also pose a substantial public health burden due to their increasing prevalence, associated co-morbidities and increased mortality (30,38,39). People living with an IMID are also more likely to develop further co-existing IMIDs compared to those without these conditions (40,41). This is thought to be due to multiple shared susceptibility loci among major IMIDs and shared inflammatory pathways, however, this is not fully understood and is an emerging area of research (29,42,43). Furthermore, there are no current cures for these conditions (38), and the

chronic and disabling nature of IMIDs results in significant socioeconomic impacts due to loss of productivity and burden on healthcare systems (44–46).

The skin appears to be one of the areas prone to IMIDs. This is theorised to be due to the skin being the outer physical barrier of the body, which is frequently exposed to microbial, chemical and environmental factors, coupled with its network of immune cells and immune system interactions to maintain homeostasis (1,3,28,47).

1.4 PSORIASIS

One of the most common IMIDs is psoriasis, a chronic inflammatory skin disease, which affects approximately 60 million people globally, and 1.1 million adults in the UK (48,49). It involves dysregulated communication between cells of the innate and adaptive immune systems and is characterised as being a T-cell mediated condition, where the primary cytokines involved are IL-17, IL-22 and IL-23 (49). This dysregulation leads to the amplification and self-sustaining cycle of inflammation, keratinocyte hyperproliferation and the formation of psoriatic plaques on the skin (49,50). The development of psoriasis is theorised to arise from complex interactions between a susceptible genome and environmental factors, that lead to alterations in the innate and adaptive immune systems that sustain a cycle of chronic inflammation through a proinflammatory cascade (31,49). Once developed, psoriasis is a chronic, life-long condition (49).

1.5 PREVALENCE AND INCIDENCE OF PSORIASIS

Psoriasis can occur at any age but is more common in adults than children, it affects men and women equally (51), with a mean onset age of 33 years, with 75% of cases occurring before the age of 46 years (52,53). It is estimated that over 60 million people worldwide are living with psoriasis (54). The reported prevalence of psoriasis among populations varies globally, from 0.09% to 11.43% (48), however populations assessed, and methodological differences make it difficult to confirm. Moreover, only 19% of countries have epidemiological data on psoriasis, which suggests that this is an underrepresentation of

the actual prevalence (51,54). The Global Psoriasis Atlas, a global research initiative, are currently working to try and fill this knowledge gap, to better understand the global prevalence and impact of psoriasis (54). Evidence so far suggests that psoriasis is more common in Caucasian populations compared to other ethnic groups, in high-income countries, and in regions with older populations (48,51). In adults, approximately 1.07% 3.46% of Western Europeans, 0.63%-3.60% of high-income North Americans, and 0.05% - 0.40% of East Asians (51) are affected by psoriasis. However, these findings are based on the aforementioned limited epidemiological data on psoriasis globally (51,54). In the UK, psoriasis is estimated to affect around 2% of the adult population, approximately 1.1 million people (54). Psoriasis incidence rates are not clear, due to methodological and research limitations, but studies indicate that an apparent upward trend in psoriasis cases is observed in several countries (55). Notably, data from the United States (56), China (57,58), Spain (59,60), and Norway (61) have indicated an increase in the prevalence of psoriasis over the last 30 years.

1.6 ENVIRONMENTAL TRIGGERS FOR PSORIASIS

The most well-established environmental triggers for psoriasis include stress (49,62), infections (63), excessive alcohol consumption (64), and smoking (62,65,66). The progression of non-psoriasis to psoriasis involves complex interactions between environmental factors and genetic susceptibility, which are yet to be fully understood (49) and may be caused by multiple triggering factors rather than a singular one. However, research suggests that certain environmental factors activate the immune system, and the genetic profile of an individual may influence the threshold for immune activation or regulation of the subsequent immune response (66,67).

1.7 GENETIC SUSCEPTIBILITY FOR PSORIASIS

Regarding genetic susceptibility, genome wide association studies (GWAS) have identified over 60 genetic loci that are associated with psoriasis risk (66,67). These are mainly involved in functions related to the immune system, and regulation of keratinocyte

differentiation and hyperproliferation (67,68). The main genetic determinant for psoriasis susceptibility is PSORS1, located within the major histocompatibility complex (MHC) region on chromosome 6p21 (66,67), which is involved in antigen presentation (69,70). The most significant risk allele for psoriasis susceptibility is the human leukocyte antigen (HLA)-C*06:02, located at PSORS1 (67,71). HLA-C*06:02 is involved in the immune response mediated by T cells through presenting antigens to $CD8^+$ T cells, the main inflammatory T cells that migrate to the epidermis (66). Additional single nucleotide polymorphisms (SNPs) associated with psoriasis result in increased NF-κB signalling in keratinocytes, which may lead to the overproduction of pro-inflammatory cytokines (72,73).

Research has shown that the prevalence of some psoriasis susceptibly alleles are higher in Caucasians than in other individuals (74,75). This may go some way in explaining the increased prevalence of psoriasis in Caucasian populations globally (51,74).

1.8 CLINICAL MANIFESTATION OF PSORIASIS

There are several types of psoriasis, all of which have distinctive clinical phenotypes (49). The most common type of psoriasis is plaque psoriasis (psoriasis vulgaris), which accounts for approximately 80-90% of all psoriasis cases globally (48,49). Plaque psoriasis typically manifests as raised scaley plaques on the skin, which are reddish pink on lighter skin tones and greyish on darker skin tones (49) as shown in Figure 3. Psoriasis can affect all areas of the body, with common sites including the scalp, elbows, nails, buttocks, knees, and shins (49). Plaque psoriasis is commonly classified based on the affected anatomical location, inverse psoriasis, is found in skin folds, palmoplantar, affects the soles of the feet and palms of the hands and sebopsoriasis, predominantly impacts the scalp and parts of the face (48,49).

Figure 3. Picture of plaque psoriasis on white skin (left) and a picture of plaque psoriasis on skin of colour (right). Taken from PAPAA clinical images bank (76).

Less common clinical subtypes of psoriasis include: guttate, which constitutes 2% of all cases of psoriasis and involves acute onset of small erythematous plaques; erythrodermic which affects 2-3% of PLwP and presents as erythema covering over 75% of total body surface area, (49,77); and pustular psoriasis characterised by sterile pustules, which makes up < 5% of all psoriasis cases (49). The different types of psoriasis demonstrate variations in the predominant inflammatory pathways involved, which can influence the presentation of the condition (49). It is possible for PLwP to develop more than one type of psoriasis simultaneously (48).

Common symptoms of psoriasis include scaling, itching, swelling, burning, cracking and bleeding of affected skin and skin pain (78,79). Psoriasis can fluctuate in severity, following a relapsing and remitting cycle (49). The most widely used tool for the measurement of severity of psoriasis is the Psoriasis Area Severity Index (PASI) (48,49). This combines the severity of three clinical signs: erythema (redness), induration (thickness) and desquamation (scaling) of plaques present and the percentage of body surface area involved, to produce a score. The higher the PASI score, the more severe the disease (80).

The definitions of severity vary, but are often grouped into mild, moderate, and severe, see Figure 4. (80). However, there are certain limitations to the PASI score which includes the subjectivity of those using it as a measure and it does not consider relevant patient-reported outcomes such as pain, itch and impact on daily life (48,81).

Psoriasis is diagnosed clinically, based on medical and family history, distribution and appearance of skin lesions. In atypical cases a skin biopsy may be taken to confirm psoriasis, however there are no biomarkers for psoriasis diagnosis or progression or severity (49).

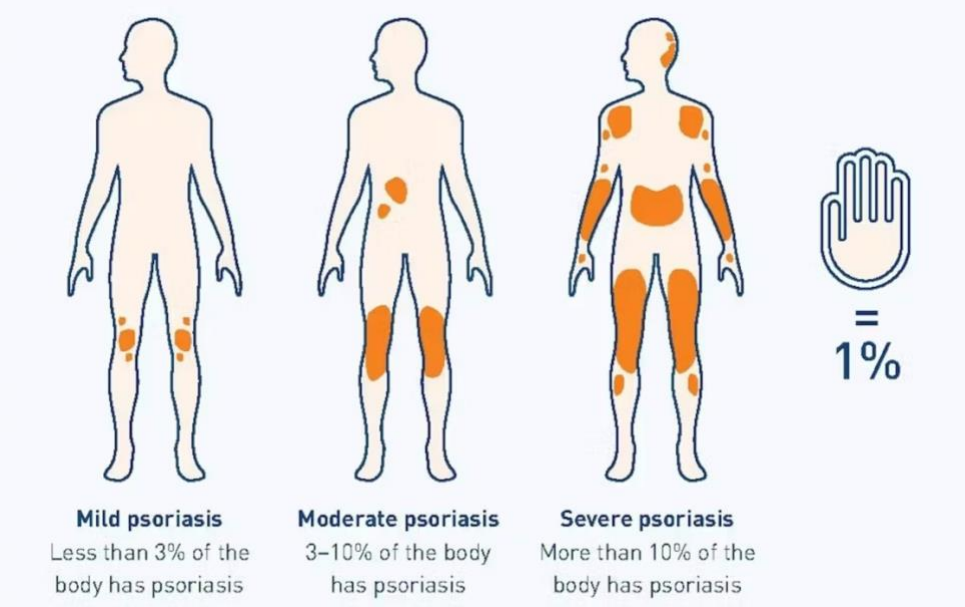

Figure 4. Diagrammatic overview of mild, moderate and severe psoriasis. Taken from national Psoriasis Foundation (82).

1.9 PSORIASIS: A SYSTEMIC DISEASE

The chronic inflammation extends beyond the skin in psoriasis, and it is now recognised as a systemic disease rather than solely dermatological (83,84). Compared with healthy controls, PLwP have increased serum levels of proinflammatory cytokines including IL-6 (85), IL-17 (86), IL-22 (87) and TNF-a (88–90) and of the inflammatory biomarker C-reactive

protein (CRP) (83,91,92). Research also suggests that increased levels of these proinflammatory cytokines are associated with increased psoriasis severity (85). This chronic inflammation negatively impacts various tissues and organ systems (93,94), including the joints, and pathways regulating adipose, metabolic, and endothelial functions, which can result in metabolic dysfunction and vascular changes (95).

Numerous studies have reported an association between psoriasis and various diseases (96–100). Most commonly with psoriatic arthritis (PsA), a progressive inflammatory condition of the joints (101). It is estimated that approximately 20-30% of people living with psoriasis will develop psoriatic arthritis, typically 10 years after psoriasis onset (98,101). Psoriatic arthritis is also reported to be more common among those with more severe psoriasis and longer duration of the condition (102). Obesity is also associated with psoriasis, and research suggests a bi-directional relationship. Increased adiposity and obesity are risk factors for psoriasis (103) and obesity is more common in PLwP compared to the general population, with severe psoriasis associated with greater odds of obesity compared to those with mild psoriasis (99).

Psoriasis is associated with an increased prevalence of cardiovascular risk factors and is an independent risk factor for the development of cardiovascular disease (CVD) (104). Several factors contribute to endothelial dysfunction in psoriasis, including elevated levels of circulating proinflammatory cytokines, circulating lipids and platelets, and the increased prevalence of cardiovascular risk factors (95,105). These factors act synergistically to directly and indirectly activate endothelial cells and impair their function, resulting in a pro-atherogenic state, and subsequent development of cardiovascular disease (106).

People living with psoriasis have an increased risk of CVD compared to the general population (107). Various reviews and meta-analyses also show that the prevalence of CVD risk factors including type 2 diabetes mellitus (100,108), hypertension (109), dyslipidaemia (110), and obesity (99), as well as adverse cardiovascular outcomes, including myocardial infarction (111), stroke (112), and cardiovascular death (105,113), are increased in patients with psoriasis compared to the general population. Furthermore, research suggests that people living with severe psoriasis may have an increased risk of CVD independent of

traditional risk factors (104,114). Psoriasis is also associated with non-alcoholic fatty liver disease (115) and inflammatory bowel disease (97).

Commonly associated co-morbidities share key inflammatory pathways with psoriasis, shown in Figure 5. (93). Mechanistic studies suggest that the primary drivers of comorbidity association lie in the proinflammatory milieu of psoriasis. Elevated levels of Th1 inflammatory cytokines, such as TNF-a, IL-1β, and IL-6, in both skin and serum disrupt insulin signalling, lipid metabolism, and adipogenesis (116). Additionally, inflammation induced insulin resistance may foster a systemic insulin-resistant state leading to metabolic syndrome development (117). Research indicates that psoriasis-related cytokines, including TNF-α, IL-1β, and IL-6, can contribute to obesity by influencing triglyceride metabolism and adipocyte differentiation (118). However, further research is warranted to elucidate the exact mechanisms.

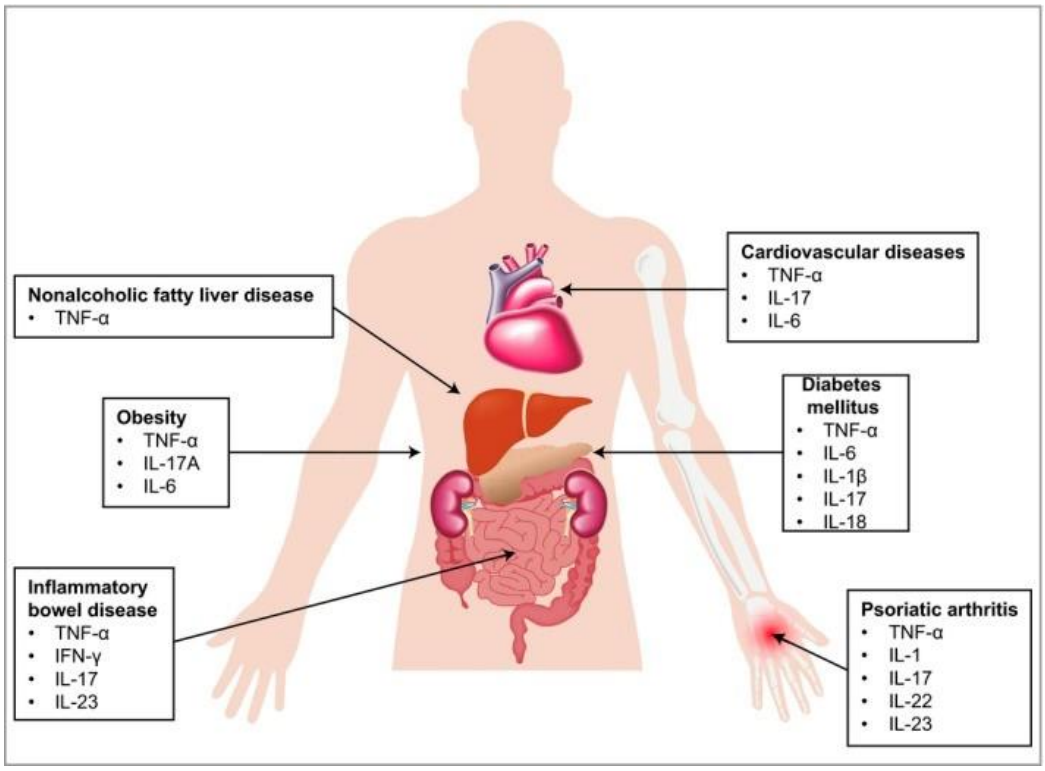

Figure 5. Psoriasis associated co-morbidities and the key shared inflammatory cytokines, Korman et al. 2020 (93).

1.10 QUALITY OF LIFE

Psoriasis does not only have an impact on physical health but can also impact the quality of life (QoL) and well-being of those affected. In 2014, the World Health Organization (WHO) recognised psoriasis as a "*chronic, non-communicable, painful, disfiguring and disabling disease which has a negative impact on quality of life (QoL)"* (48). People living with psoriasis experience a significant physical and psychological burden which impairs well-being, even when symptoms are mild (79,119). The painful and debilitating symptoms of psoriasis alongside the chronic nature of the disease, treatment dissatisfaction and social stigmatisation impacts the social, personal and work lives of those living with the disease (48).

People living with psoriasis have an increased risk of psychiatric disorders (120,121). Both the psychological impact of living with a chronic skin condition, alongside the systemic inflammation seen in PLwP, may contribute to the development of the psychiatric comorbidities such as depression and anxiety (120,122). The economic burden of psoriasis is significant and increases with the onset and number of comorbidities (122,123).

Greater impact is seen in those with increased severity or with psoriasis that involves visible or functional areas including the face, palms, and genitalia. People with severe psoriasis report a greater number of days absent from work or school than those with non-severe psoriasis (124) and have significant impairment of work productivity (125). The personal economic burden, of missing work, and in some countries paying for psoriasis treatment, also plays a role in impairing the QoL of PLwP (126). Skin clearance, which refers to clearing psoriasis plaques from the skin and the cessation of symptoms, is reported to be the most meaningful outcome for PLwP (48,127). Studies show that PLwP who experience improvements in disease severity commonly experience improvements in QoL (127,128).

The concept of 'cumulative life course impairment' (CLCI), introduced by Kimball et al. in 2010 (129), suggests that the persistent burden of psoriasis over a lifetime can alter patients' life trajectory, leading to irreversible damage. The CLCI concept recognises that

the burden of stigmatisation, associated comorbidities, and coping strategies interact to cause lifetime impairment throughout the lives of PLwP.

1.11 CURRENT TREATMENT FOR PSORIASIS

There is no cure for psoriasis; thus, treatment focuses on symptom management (48,49). Therapeutic options include topical agents, such as corticosteroids and vitamin D analogues; phototherapy with ultraviolet radiation, which act as a local immunosuppressants, and systemic immunosuppressants, such as methotrexate and cyclosporine (49). More recently biologics and biosimilars, which target specific components of the immune system, including IL inhibitors and anti-TNF-α agents have advanced the treatment of psoriasis (48,49,130). A combination or alternation of these therapies is often used depending on severity, patient preference and treatment goals (48,49). For example, phototherapy with ultraviolet B (UVB) may be used in combination with biologic therapies including TNF-a inhibitors (130) to increase efficacy. Due to the chronic nature of psoriasis and the associated co-morbidities, treatment is usually lifelong and often requires a multidisciplinary approach involving dermatologists, rheumatologists, and primary care HCPs (48).

Despite the advancements in psoriasis management, several challenges and unmet needs persist (131). Side effects, treatment resistance, long-term efficacy, safety concerns, and high costs of certain treatments limit their use and efficacy. For example, although biologics are effective and have advanced the treatment of psoriasis, relapse is a challenge for current treatments, psoriatic lesions frequently return following cessation of biologic use (132,133). Moreover, in cyclosporine use, a systemic treatment for moderate to severe psoriasis, relapses are often seen on withdrawal, and long-term treatment is limited by adverse effects, notably renal dysfunction and hypertension (10,134).
Methotrexate, one of the most frequently prescribed non-biologic medications that plays a key role in the management of severe psoriasis, requires patients to be closely monitored for liver damage (10,134). Moreover, a large cross-sectional study found that 52.3% of

patients with psoriasis report dissatisfaction with their medical treatment, stating treatment inefficacy and adverse effects as the main reasons for this (135).

Furthermore, the variability in treatment response among individuals highlights the need for personalised and tailored approaches in psoriasis management (134,136). Recent research has explored the application of -omics technologies to predict responses to psoriasis medications. The HLA-C*06:02 variant, which is associated with psoriasis susceptibility, is a predictor of positive response to Ustekinumab and negative response to Adalimumab, biologics used in the treatment of psoriasis (137–139). However, this is a new area of research and limited studies have been conducted on this.

The cumulative impact of the chronic nature of psoriasis, painful symptoms, need for lifelong treatments which may have various side effects, and the development and consequences comorbidities, contribute to a considerable burden of disease (BoD) for PLwP (79,94,122). An overview of which is presented in **Figure 6.** This highlights the need to investigate approaches that could have a beneficial impact on both psoriasis and the BoD, particularly by addressing comorbidities. There are well established links between unhealthy lifestyle factors, such as smoking (62,140), excessive alcohol consumption (64,141), obesity (99,118) and a sedentary lifestyle (142), with the onset and worsening of psoriasis and the comorbidities. In recent years there has been a growing demand for more research into the role of diet in psoriasis management, from both PLwP and HCPs (143), due to its potential to reduce inflammation and positively impact overall health. Furthermore, adequate nutrition is required for optimal immune system function (144). However, there is limited understanding of the impact of diet on psoriasis, how PLwP perceive and implement dietary changes, and the support they receive.

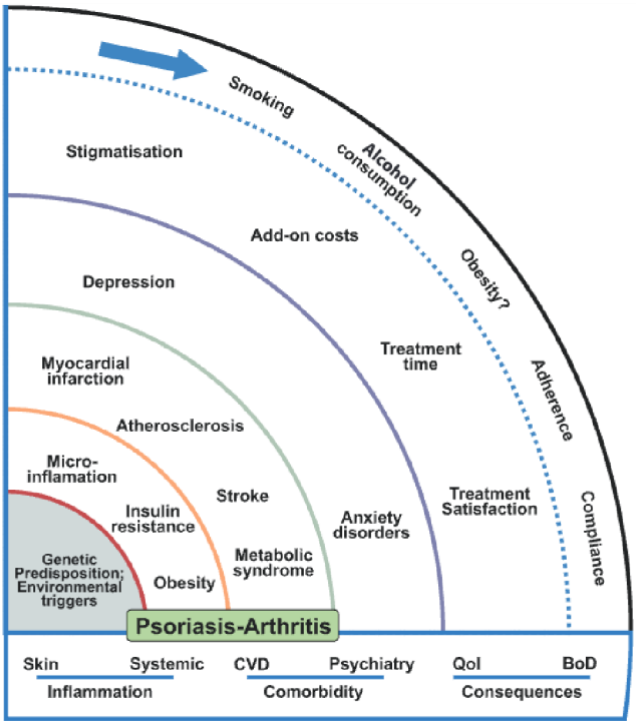

Figure 6. Diagrammatic overview of the burden of disease and associated co-morbidities of psoriasis. BoD: burden of disease; CVD: cardiovascular disease; QoL, quality of life. Diagram from Mrowietz et al. 2014 (94).

1.12 THE POTENTIAL ROLE OF DIET IN PSORIASIS MANAGEMENT

Diet has been found to reduce systemic inflammation and influence levels of pro- and anti-inflammatory cytokines and inflammatory biomarkers (145,146), which could play a role in psoriasis management. Weight loss via calorie-restriction, certain dietary patterns, and macro- and micronutrients have been shown to have an impact on modulating inflammation (147). Many polyphenols, particularly flavonoids, possess potent anti-inflammatory and immunoregulatory properties. Dietary patterns rich in saturated fatty acids and trans fats have been shown to promote inflammation (148,149). In contrast, diets high in polyunsaturated fatty acids (PUFAs), monounsaturated fatty acids (MUFAs), and fibre have been shown to attenuate the inflammatory cascade (146,147,149). While there is no precise definition for an anti-inflammatory dietary pattern, robust evidence suggests that the Mediterranean diet demonstrates anti-inflammatory properties and reduces inflammatory biomarkers, including IL-6 and TNF-a (146,150). However, there are no

specific dietary guidelines and thus demand for research exploring the role of diet in psoriasis management is high (143).

1.13 THESIS RATIONALE

The absence of specific dietary guidelines for psoriasis, alongside limited understanding of impact and implementation of dietary highlights an important knowledge gap. Thus, there is a high demand for evidence on diet in the management of psoriasis from PLwP and HCPs involved in their care (143). A crucial part of understanding the role of diet in the management of psoriasis is understanding the current evidence, as well as exploring the needs, perceptions, experiences and acceptance of dietary support of people living with psoriasis (PLwP). Gaining insight into these aspects can help inform patient-centred care approaches (151–153). Patient-centred care focuses on addressing the needs, preferences, and values of patients and has been shown to positively impact the quality of healthcare, certain health status indicators and people's ability to participate in managing their own condition, especially in chronic or long-term conditions (154–157). Moreover, understanding this is especially important in facilitating discussions between HCPs and patients about diet, and aiding the integration of nutrition into care. This is vital considering the high demand for dietary information, associated co-morbidities, the role of diet in overall health and in the absence of dietary guidelines (158). This gap in knowledge underscores the need for comprehensive research to understand the role of diet in managing psoriasis and to provision of support for PLwP.

Exploring the perspectives and experiences of PLwP regarding diet will provide much needed evidence to enable healthcare professionals (HCPs) and support organisations to develop holistic care strategies that improve overall health and facilitate discussions on diet. This is especially important without formal dietary guidelines being present. The findings have the potential to inform comprehensive, evidence-based dietary support for PLwP, highlight key knowledge gaps, facilitate discussions on diet between HCPs and patients, and enhance comprehensive care.

1.14 AIM

The aim of this PhD is to explore the role that diet plays in the management of psoriasis to better understand how best to support people living with psoriasis in the absence of dietary guidelines, in the United Kingdom.

1.15 OBJECTIVES

1. To systematically review the current literature on diet and psoriasis.

2. To explore the experiences, utilisation and perceived effectiveness of dietary modifications among adults living with psoriasis in the UK.

3. To develop and evaluate a user-friendly dietary support resource for adults living with psoriasis in the UK.

1.16 PATIENT AND PUBLIC INVOLVEMENT AND ENGAGEMENT

Public and patient involvement and engagement (PPIE) in research is an active partnership between patients, the public, and researchers in the research process. It is defined as doing research 'with' or 'by' people who use services rather than 'to', 'about' or 'for' them (159). It can be implemented in various ways and can include, undertaking interviews with research participants, providing expert by experience advice on a steering committee to inform research priorities, or aiding in the development of interventions or research materials. PPIE played a key role in informing the research conducted throughout this thesis. The involvement of PLwP occurred at multiple stages. This included: the analysis of individual interviews with people living with psoriasis in Chapter 3, an individual with psoriasis reviewing the content, format, and wording of the questionnaire undertaken in Chapter 4, and collaboration with three individuals living with psoriasis as part of the expert panel and incorporating feedback from 34 PLwP as part of the methodology utilised in Chapter 5. Engaging with the Psoriasis Association and Psoriasis and Psoriatic Arthritis Alliance (PAPAA) promoted participation and engagement in the

research conducted. Engaging with people living with psoriasis deepened my understanding of the challenges and burdens faced in addition to providing insights into their experience with diet. The inclusion of PPIE throughout this thesis ensured that the research conducted aligned with meaningful outcomes for disease management, reinforcing the relevance of this research to PLwP.

1.17 METHODOLOGY OVERVIEW

This thesis involved exploratory studies that employs a mixed methods sequential design to comprehensively explore the role of diet in the management of psoriasis. Due to the scarcity of literature on this topic among a UK population, an explorative research design was implemented to enhance understanding and provide novel and in-depth insights. Throughout the thesis a purposeful use of both qualitative and quantitative methods was used to inform subsequent stages of the research, to achieve the aims and objectives. This section provides a brief overview of the methodology employed throughout this thesis, and a more detailed explanation of each methodology used is given in each relevant chapter.

A mixed method approach enables the complementary strengths of both qualitative and quantitative methodologies to be combined. Qualitative research offers in-depth insights into the real-world experiences and individual perceptions, and hard to measure constructs, which enhances the understanding of a specific issue, especially in under-explored areas (151,160,161). This can inform subsequent research that is appropriate and relevant to participants. Quantitative research can efficiently collect data from larger populations, provide objective, numerical data and findings can be generalised to broader populations (162). Therefore, combining these methods enables researchers to gain a more complete picture, capturing not just what happens, but also why and how. It is therefore an appropriate methodology for exploring dietary use and experience in chronic disease management, especially in an area of limited understanding, a primary aim of this thesis. Furthermore, there is growing recognition of the advantages of undertaking mixed methods research in healthcare (163) and it has been shown to be useful in understanding how patients perceive their health, insights into decision-making experiences, and in understanding whether patient health information is clear and appropriate (164–166).

Hence the use of this methodology to achieve the objectives of this thesis. Furthermore, in emerging fields, such as diet and psoriasis, mixed methods can provide a valuable approach to enable exploration and theory building (167). A mixed-methods study design is therefore particularly appropriate for this thesis, as it enables in-depth exploration of individual experiences through qualitative methods, highlighting issues that may not be immediately apparent. These insights can then inform quantitative studies to understand the broader patterns of the use of diet and highlight areas that require further research.

The research for this thesis began with a scoping review to comprehensively identify and map the current evidence on the emerging field of the use of diet for the management of psoriasis. This was conducted using the guidance produced by the Joanna Briggs Institute (JBI) for conducting scoping reviews (168) (Chapter 2). Scoping reviews follow a structured process to systematically search evidence, similar to a systematic review (169). However, they have a more expansive inclusion criteria which allows them to identify and interpret evidence on an emerging area of research, from studies utilising a range of methodologies, and from non-research sources, such as grey literature and patient information (168,169). The role of diet in the management of psoriasis is an emerging area of research. Therefore, to comprehensively map the current evidence base on this broad topic, a scoping review was deemed the most appropriate methodology, compared to narrower systematic review methodology (168,169).

Subsequently, thematic analysis of individual interviews was undertaken to build on the scoping review's insights and explore perspectives, experiences, and motivations related to diet and psoriasis management among UK adults (Chapter 3). The data was analysed using thematic analysis to provide a deep understanding of the data by identifying similar experiences and overarching themes of the perspectives of the participants (170). This was an essential initial step in understanding the key issues and dietary practices of PLwP in the UK, which were previously unknown, to provide rich data to inform subsequent relevant research.

A quantitative questionnaire was subsequently conducted (Chapter 4), informed by findings from the qualitative phase (Chapter 3). The questionnaire enabled data to be

collected on frequencies and investigate patterns of dietary practices from a larger cohort of PLwP UK adults. A crucial step to gain a more comprehensive understanding of this area, and to identify areas for further research. The survey also integrated qualitative text boxes to allow participants to provide additional context and insights where relevant, to further enrich the study with qualitative perspectives on a key area.

Finally, integrating insights from all previous phases, user-centred design (UCD) methodology was employed to collaboratively develop a nutritional support guide tailored for people living with psoriasis (Chapter 5). This approach sought to ensure that the final guide was both relevant and user-friendly for intended users, PLwP (171). The final guide was then evaluated to measure the perceived usability of the guide by intended users (172).

1.18 THESIS OUTLINE

This thesis comprises 6 chapters which include published research papers, alongside introduction and discussion chapters.

Chapter 1: Background and thesis overview

This chapter provides relevant background to the thesis and presents the rationale for the research conducted. It also provides an overview of the thesis layout.

Chapter 2: The role of diet in the management of psoriasis: a scoping review

The aim of this chapter is to review the evidence on the use and effectiveness of diet in the management of psoriasis. It includes a range of available evidence on dietary intake, the perceived role of diet in psoriasis management and evidence from dietary intervention studies on the impact of psoriasis severity and symptoms. This chapter also explores the relevant grey literature and advice available to people living with psoriasis, regarding diet. It is hypothesised that there will be a lack of large, randomised control trials, and a range of different studies conducted regarding the role of diet in psoriasis management, with varying methodologies.

Chapter 3: People living with psoriasis require guidance to navigate popular dietary information: a qualitative study of UK adults

This chapter uses individual interviews conducted with people living with psoriasis in the UK to provide in-depth insight into the experiences and perceived use and effectiveness of using diet in the management of psoriasis, from those with lived experience. It is hypothesised that PLwP in the UK implement a wide range of unsubstantiated dietary modifications, which may be restrictive, to try and help alleviate psoriasis symptoms.

Chapter 4: Diet and psoriasis management: A UK cross-sectional study exploring the self-reported dietary modifications, experiences, and skin responses of people living with psoriasis

This chapter aims to gain further insight and explore the findings of Chapter 3 in a larger UK psoriasis population, through a cross-sectional questionnaire exploring dietary modifications, skin responses, patient experiences, and information acquisition. It is hypothesised that PLwP in the UK trial restrictive and non-evidence based dietary modifications to try and manage their psoriasis, and that their perceived skin responses to dietary modifications may vary. The type of dietary modification trialled may be associated with different demographic factors. Additionally, regarding dietary information, it is hypothesised that the majority obtain dietary information from unsubstantiated sources rather than from healthcare professionals and want more dietary support.

Chapter 5: User-centred design and evaluation of a tool for people living with psoriasis in the UK to navigate nutritional information

This chapter uses a user-centred design approach, involving intended users of the guide and an expert panel to develop user-friendly and evidence-based guidance to address the identified lack of dietary support for PLwP. The aim of the guidance is to assist PLwP to make informed decisions regarding their dietary choices and management of their condition. It is hypothesised that involving PLwP and an expert panel will result in the development of a dietary support resource that has good to excellent perceived usability by PLwP in the UK.

Chapter 6: Discussion, conclusion and future research

This chapter will give an overview of this thesis' findings and how they relate to existing literature and add to the wider research field. It will examine both the strengths and limitations of the research conducted and discuss the implications and relevance within the context of comprehensive and patient-centred psoriasis care, and suggestions for potential directions of future research.

Thesis hypothesis

It is hypothesised that there is insufficient evidence to provide specific dietary guidance for all people living with psoriasis (PLwP). The absence of clear, evidence-based dietary recommendations may contribute to PLwP in the UK adopting restrictive diets from unregulated sources, and PLwP need more dietary support.

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CHAPTER 2 THE ROLE OF DIET IN THE MANAGEMENT OF PSORIASIS: A SCOPING REVIEW

CHAPTER SUMMARY

In this chapter, I present a published scoping review that summarises the literature on dietary intake, the perceived role of diet in psoriasis management and evidence from dietary intervention studies on the impact of psoriasis symptoms. Additionally, relevant grey literature was reviewed. Overall, the review included 72 peer-reviewed studies as well as 77 relevant grey literature resources. It is hypothesised that there will be a lack of large, randomised control trials, and a range of different studies conducted regarding the role of diet in psoriasis management, with varying methodologies. Making it difficult to provide specific dietary guidance for all people living with psoriasis (PLwP).

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CONTRIBUTION

Poppy Hawkins: developed search strategy, performed scoping review, screening and interpretation of included literature, and drafted the manuscript. Rosalind Fallaize, Kate Earl and Athanasios Tektonidis contributed to the study design and drafting of the manuscript. All authors included reviewed and approved the final manuscript.

2.1 ABSTRACT

Psoriasis is a chronic, systemic, immune-mediated, inflammatory skin disease associated with significant comorbidities. Globally, there are an estimated 60 million people living with psoriasis (PLwP). There is a growing body of evidence on the role of diet in psoriasis management, and demand for dietary advice is high. However, there are no specific, evidence-based dietary guidelines. This scoping review summarises the literature on use and effectiveness of diet in the management of psoriasis to improve understanding of the evidence and assist PLwP and healthcare professionals (HCPs) to discuss diet. The findings were categorised into three themes: (1) dietary intakes of PLwP, (2) the perceived role of diet in psoriasis management and (3) dietary approaches to manage psoriasis symptoms. In cross-sectional studies PLwP were reported to have higher fat and lower fibre intakes compared with controls, and lower psoriasis severity was associated with higher fibre intake. However, research is limited. PLwP perceive diet to have an impact on symptoms and make dietary modifications which are often restrictive. Systematic reviews and RCTs found certain dietary approaches improved symptoms, but only in specific populations (e.g. PLwP with obesity and PLwP with coeliac disease), and evidence for supplement use is inconclusive. The grey literature provides limited guidance to PLwP; focusing on weight loss and associated comorbidities. Larger, controlled trials are required to determine dietary approaches for psoriasis management, especially in PLwP without obesity and non-coeliac PLwP. Further understanding of diet modification, information acquisition and experiences among PLwP will enhance holistic care for psoriasis management.

2.2 INTRODUCTION

Psoriasis is a chronic, systemic, immune-mediated, inflammatory skin disease (1) which can have a substantial impact on quality of life (QoL) through both physical and psychological effects (2). It typically presents as raised, scaly plaques on the skin (2) which can cause painful and debilitating symptoms (1) and is associated with significant arthritic, cardiovascular, metabolic, and psychological comorbidities (1,3,4). Globally, there are an estimated 60 million people living with psoriasis (PLwP) (5).

Psoriasis affects males and females equally and is more common in adults compared to children (4,6). The reported prevalence of psoriasis among adults varies globally, from 0.09% (7) to 11.43% (8), and is more common in high-income countries and in regions with older populations (1,4). The highest prevalence of psoriasis is seen in Australasia (1.99%), western Europe (1.92%), central Europe (1.83%) and North America (1.50%) (4). However, only 19% of countries have epidemiological data on psoriasis (4,5). In the United States (US) psoriasis is one of the most common immune-mediated diseases, affecting 3% of adults (9) and in the U.K psoriasis affects an estimated 2% of the population, approximately 1.1 million people (5).

There is no cure for psoriasis and treatment is focused on symptom control. Studies show that PLwP who experience improvements in disease severity commonly experience improvements in QoL (10,11). However, satisfaction and adherence to some treatments are sub-optimal due to side-effects and dissatisfaction with the time taken and degree of improvement (1,12,13). Long-term efficacy of psoriasis treatments has also been highlighted as a concern (14). Psoriasis imposes a significant economic burden, which increases with the number and onset of psoriasis-related comorbidities (15,16).

Comorbidities

Psoriatic arthritis (PsA) is the most prevalent comorbidity of psoriasis, affecting approximately 30% of people living with the disease (17) and is more prevalent in those with severe psoriasis and those who have had the disease for a longer duration (18).

Compared to the general population, PLwP have an increased risk of cardiovascular disease (CVD) (3) and people with more severe psoriasis have increased odds of developing CVD, compared to those with mild-to-moderate psoriasis (19). It has been suggested that psoriasis may be an independent risk factor for CVD (3). Multiple cardiovascular risk factors are also associated with psoriasis including, type 2 diabetes (20), obesity (21), metabolic syndrome (22), dyslipidaemia (23) and hypertension (22). Furthermore, meta-analyses have also associated psoriasis with non-alcohol fatty liver disease (24), certain cancers (25) and inflammatory bowel disease (26).

Psoriasis also has a substantial psychological impact. PLwP are 1.5 times more likely to have symptoms of clinical depression compared with healthy controls (27). Living with a chronic condition, social stigmatisation and low self-esteem play a significant role in the development of depression in PLwP (1), and emerging evidence suggests that systemic inflammation could also be playing a role in this relationship (28).

Aetiology and Pathophysiology

The onset of psoriasis is multifactorial and is theorised to occur due to a combination of genetic and environmental factors which trigger a dysregulated immune response, that activates and sustains a cycle of inflammation (29,30). Multiple components of the adaptive and innate immune systems are involved in this process (2,30). The inflammatory cascade in psoriasis starts when plasmacytoid dendritic cells are activated which promotes myeloid dendritic cell maturation through production of interferon (IFN) -α, IFN-γ, tumour necrosis factor (TNF)-α, Interleukin (IL)- 1β (31). This leads to the activation and production of multiple cytokines, chemokines and antimicrobial peptides that promote an ongoing proinflammatory response. These include, TNF-α, IL-6, -12 and –23, which activate T helper (Th)1, Th17 and Th22 cells (32) , which help to sustain the self-driving cycle of inflammation by producing TNF-α, IFN-γ, IL-17 and IL-22 (29–31,33,34). This response leads to epidermal keratinocyte hyperproliferation and maintains a continual cycle of inflammation (29,30,33,35). The key role that the IL-17/IL-23 axis plays in psoriasis, as well as specific cytokines such as TNF-α, is demonstrated by the efficacy of biological medications which target these specific cytokines and pathways (2) (Figure 1.).

Compared to healthy controls, PLwP have increased serum levels of proinflammatory cytokines (36,37), continual elevated levels of which can lead to chronic subclinical systemic inflammation (35). Hence why psoriasis is now seen as a systemic disease, rather than solely dermatological (35). The systemic inflammation seen in psoriasis is theorised to contribute to the pathogenesis of many of the associated comorbidities (2,35,38,39).

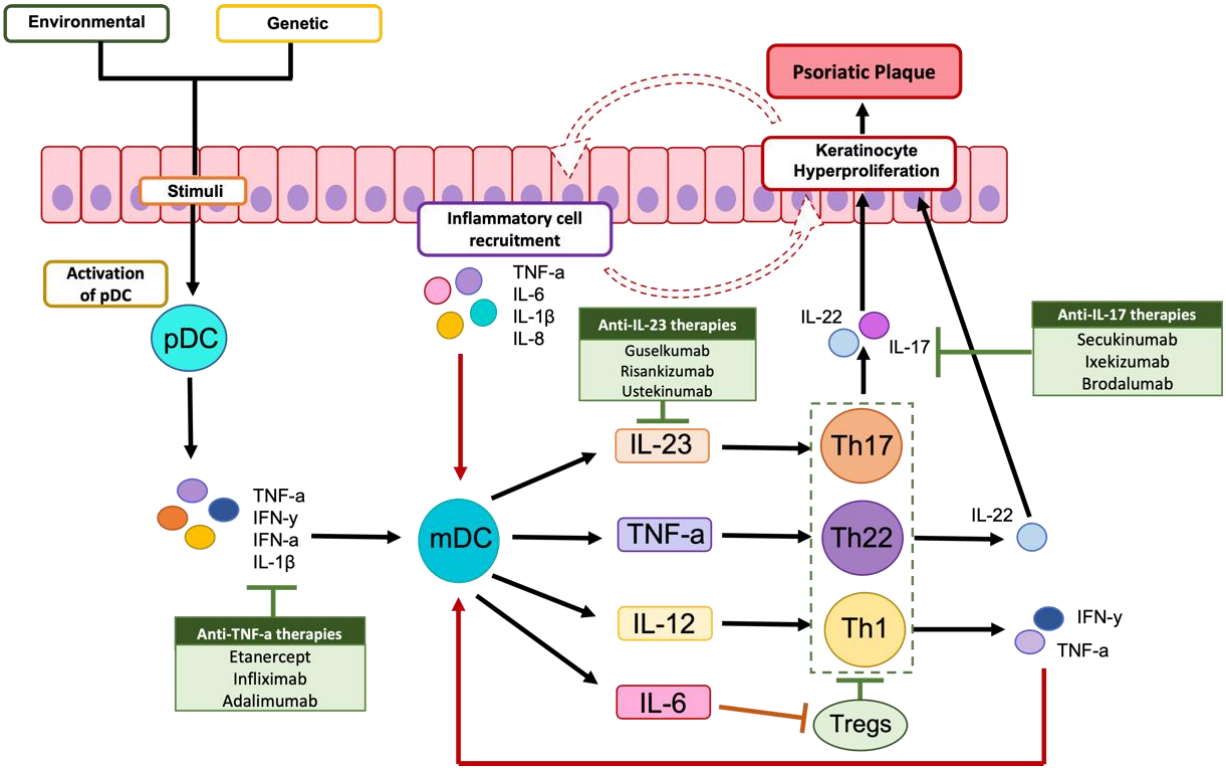

Figure 1. Diagrammatic overview of the immune response, keratinocyte hyperproliferation and self-sustaining cycle of inflammation in psoriasis. Plasmacytoid dendritic cells (pDC), Myeloid dendritic cells (mDC), Interleukin (IL), Tumour necrosis factor (TNF), Interferon (IFN), T-helper cells (Th), Regulatory T-cells (Tregs).

Lifestyle management for Psoriasis

People living with psoriasis often look to lifestyle changes to manage their symptoms. The James Lind Alliance Priority Setting Partnership on psoriasis identified the top research priority for the disease as “Do lifestyle factors such as diet, dietary supplements, alcohol, smoking, weight loss and exercise play a part in treating psoriasis?” in 2018 (40). Lifestyle factors such as smoking, alcohol intake and stress have been shown to affect disease

severity (1) but there is limited knowledge on the role of diet in managing psoriasis. Evidence suggests that diet can modulate immunological and inflammatory responses (41) and certain nutrients or dietary patterns could potentially worsen or alleviate psoriasis symptoms (42). However, there are no specific dietary guidelines for psoriasis.

There is a growing body of scientific literature regarding the role of diet in the management of psoriasis, alongside an increasing amount of “popular” dietary advice (43–45). Studies have shown that in PLwP dietary modification is common, and that many are self-initiating dietary changes (43–45). It is therefore important for HCPs to familiarise themselves with the current literature on diet and psoriasis (43). By doing so, they will be able to provide informed support, combat misinformation, and discuss the role of diet in managing psoriasis with PLwP (43,46). This is particularly important considering the associated comorbidities (1) .

2.3 OBJECTIVES OF THIS REVIEW

The aim of this scoping review is to provide a comprehensive overview of the available evidence on the role of diet in the management of psoriasis. It will summarise the literature on dietary intake, the perceived role of diet in psoriasis management and evidence from dietary intervention studies on the impact of psoriasis symptoms. Additionally, this review will consider relevant grey literature on the role of diet in the management of psoriasis. A scoping review was determined as the most appropriate method given the broad study objective that will explore a range of sources, study designs and outcome measures.

2.4 METHODOLOGY

This scoping review was conducted according to the updated methodological guidance for the conduct of scoping reviews of the Joanna Briggs Institute (47). The search was conducted by:

(1) Searching PubMed and SCOPUS using relevant key words and phrases. The key words used were; Psoriasis AND diet* OR nutrition* OR eat OR "dietary patterns" OR "dietary intake" OR "dietary behaviours" OR “dietary habits”.

(2) Searching appropriate grey literature. Grey literature is defined as “information produced on all levels of government, academia, business and industry in electronic and print formats not controlled by commercial publishing i.e., where publishing is not the primary activity of the producing body." For this scoping review we included grey literature produced by psoriasis organisations, nutritional societies and health authorities, and reports and guidelines on psoriasis management. The grey literature search strategy used was developed using methods from Godin et al. (48) for applying systematic search strategies to identify grey literature. Targeted searching of the identified resources, using appropriate search terms, was then undertaken.

(3) Screening reference lists of relevant papers, reports, and guidelines.

(4) Searching for specific dietary modifications found to have been followed by people living with psoriasis (PLwP) individually as they emerged from the studies included in the review. The terms searched for on PubMed and SCOPUS were Psoriasis AND the following: dairy-free, vegan, vegetarian, paleolithic, Pagano, ketogenic diet, low carbohydrate–high protein, red meat and nightshades.

Findings are reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses checklist for scoping reviews (PRISMA-ScR) (49), see Table 1. for checklist. PRIMSA diagram details the search and selection process applied during this scoping review. Studies were identified via database searches of PubMed and SCOPUS, and other methods. The Grey literature was identified solely via other methods as detailed in the diagram (Figure 2.).

Inclusion and Exclusion Criteria

Papers assessed for inclusion in this review were selected based on relevance by title and abstract initially, and then full paper review. The review considered all methodologies of relevant studies, however, only those written in English, focused solely on psoriasis (all types of psoriasis were included), involving dietary approaches alone, and conducted in or addressing humans over 18 years old were included. The database search included papers

published during the last 20 years, from 2002 until October 2022. The grey literature search was conducted between April and November 2022.

2.5 PRESENTATION OF FINDINGS

The literature varied widely in methodology and type. As a result, this scoping review provides an overview of the current evidence according to three main themes (1) dietary intakes of people living with psoriasis (PLwP), (2) the perceived role of diet in the management of psoriasis and (3) dietary approaches to manage psoriasis symptoms.

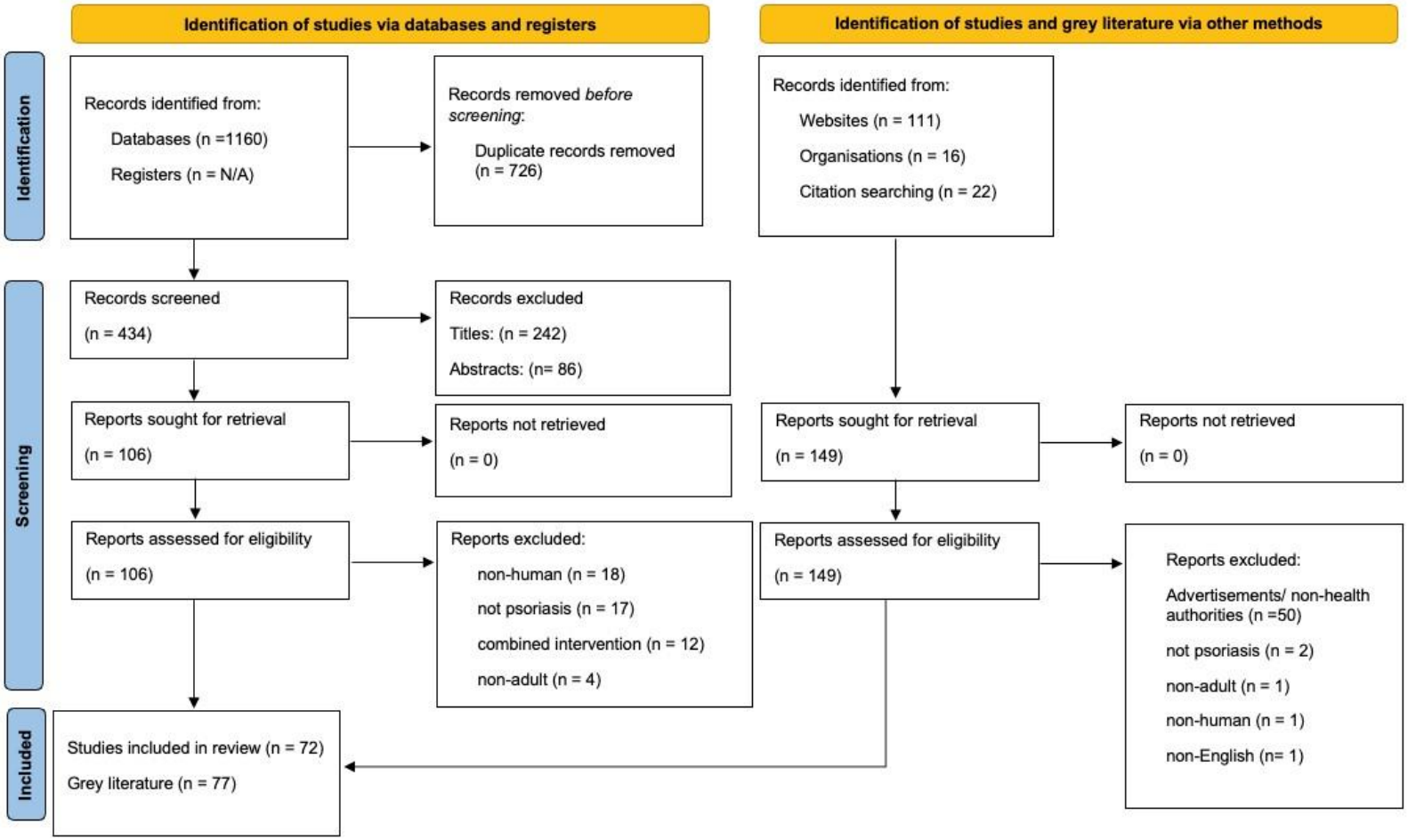

Figure 2. Figure 2. PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and other sources (167)

2.5.1 Theme 1: Dietary intakes of people living with psoriasis (PLwP)

This theme reviews studies that explored the dietary intakes and habitual supplement use of people living with psoriasis (PLwP) (Table 2). The search identified 9 studies that explored the dietary intakes of PLwP (45,50–57). Among these, 7 performed studies comparing the dietary intakes of PLwP with healthy controls (45,51–56), 1 compared the dietary intake of PLwP with adults with other chronic inflammatory conditions and recommended national dietary guidelines (57) and 6 included studies compared the dietary intakes of PLwP depending on levels of psoriasis severity (50–53,55,56) . The search also identified 2 studies that investigated the habitual supplement use of PLwP compared to controls (58,59). All studies were cross-sectional, 7 used food frequency questionnaires (FFQs) to assess dietary intake (45,50–55), 1 used 3 x 24-hour dietary recall (57) and 1 study used a 7-day food recall (56).

Several common significant differences in dietary intakes of food groups were observed between controls and PLwP. Three studies found that fat intake was significantly higher in PLwP compared to controls (51,53,56). A further study compared dietary intakes of PLwP to the recommended dietary guidelines in Poland and found that the mean dietary intakes of fat in PLwP were 148% of the recommended dietary intakes (57). However, when compared to adults with other chronic inflammatory diseases no significant difference in fat intake was observed. The absence of a healthy control group in this study meant that the findings are impossible to compare (57).

Carbohydrate intake was also found to be significantly higher in PLwP compared to controls in two studies (51,56). However, intake differences depended on the type of carbohydrate. Yazdanpanah et al. (51) found that total carbohydrate intake was significantly higher in PLwP compared to controls. Barrea et al. found that that total and simple carbohydrate intakes were significantly higher in PLwP compared to controls, whereas complex carbohydrate intake was significantly lower in PLwP when compared to controls (56). This was the only study to assess carbohydrate intake dependent on type and

was conducted in all white males (n=82), using a 7-day food recall, which makes the results difficult to compare (56).

Fibre intake was found to be significantly lower in PLwP compared to controls in three studies (45,53,56). A further study found that fibre intake of PLwP was only 53.3% in females (n=17) and 65% in males (n=22) of polish recommended dietary guidelines (30g/day). However, no significant difference was observed when compared to the dietary intakes of adults with other chronic inflammatory conditions and no healthy controls were included in this study (57).

Findings on the dairy and sugar intakes of PLwP compared to controls were contrasting. Two studies found that sugar intake was significantly lower in PLwP in the US (45,54) whereas one study conducted in Japan found that PLwP consumed significantly more sugar than controls (55). Regarding dairy intake, a large study in the US found that PLwP consumed significantly less dairy compared to controls from the 2009-2010 National Health and Nutrition Examination Survey (NHANES) (45). However, dairy intake was found to be significantly higher in PLwP compared to controls in a study conducted in Thailand (52). Only one study found that PLwP consumed significantly less protein than controls (56). However, this study was conducted in all white males (n=82), using 7-day food recall, which makes the results difficult to compare.

Regarding the intake of specific foods, several differences were observed between PLwP and controls. One study reported that PLwP had significantly higher intake of pulses compared to controls (55), and significantly higher intakes of legumes were also reported in PLwP compared to controls (45). Single studies reported that fruit and vegetables intakes were significantly higher in PLwP (45), as well as coconut milk and soft drinks (52) compared to controls. Whereas olive oil, eggs, berry fruits, brown rice/Riceberry, pickled foods and tree nuts (52), and meat (55) intake were reported to be significantly lower in PLwP compared to controls. Differences in fish and seafood intakes between PLwP and controls were found in two studies, however, results were contrasting (52,55).

Differences in dietary intakes of specific nutrients between PLwP and controls were also reported in several studies. Polyunsaturated fatty acid (PUFA) intake was reported to be significantly higher in PLwP compared to controls in two studies (53,56). Barrea et al. also found that n-6: n-3 PUFA ratio intake was significantly higher whereas n-3 PUFA intake was significantly lower in PLwP compared to controls (56). However, Kashani et al. reported that both linoleic acid and linolenic acid intakes were higher in PLwP compared to controls (53). Regarding monounsaturated fatty acids (MUFA) intake, the two studies that found significant differences in dietary intakes between PLwP and controls reported contrasting results (53,56). A further study found that females with psoriasis consumed significantly more MUFA compared to females with other chronic inflammatory diseases (57). However, no significant difference was seen in MUFA consumption in the male group and there was no healthy control group to compare intakes with. Contrasting findings on vitamin A (53,54) and calcium intake (45,53) of PLwP and controls were also reported. Single studies reported that PLwP consumed significantly higher amounts of cholesterol (56), vitamin B12, vitamin D (55) and Iron (53), and significantly lower amounts of vitamin E and folate (51) compared to controls.

One study explored the inflammatory potential of diets consumed by PLwP (n=75) compared to age-, sex- and BMI-matched controls (n=74) using FFQs and an Energy Adjusted Dietary Inflammatory Index (E-DII) as a predictive tool for inflammation potential of diets. They found that PLwP had a significantly higher energy-adjusted dietary inflammatory index with a median score of 0.10 (-1.59 to 0.83), a more pro-inflammatory diet, compared to controls where the median score was -2.14 (-2.96 to 1.00) (53).

Differences in dietary intake between those with lower psoriasis severity and those with more severe psoriasis were also reported in several studies. Those with lower psoriasis severity had significantly higher intakes of fibre (51,56), complex carbohydrates (56), vegetables (52), MUFAs, n-3 PUFAs (56) and vitamin E (51) compared to those with higher psoriasis severity. Furthermore, those with higher psoriasis severity had significantly higher intakes of total energy, saturated fatty acids, total PUFAs, n-6 PUFAs, n-6: n-3 PUFA ratio,

simple carbohydrates (56), confectionery (55) and red meat (52) compared to those with lower psoriasis severity. A single study reported that a high energy-adjusted dietary inflammatory index (E-DII) score was associated with increased severity of psoriasis (53). Polo et al. found an inverse association with adherence to a “fresh diet”, characterised by predominantly fresh foods and a high consumption of fruits and vegetables, and cutaneous activity (50). However, no definition of cutaneous activity was given, and PASI was recorded separately in this study.

Of note was that the definitions and methods for determining psoriasis severity varied between studies, and several studies did not include any definition of what constituted as lower or higher severity. Therefore, it is difficult to compare or understand the effects of these dietary intakes on psoriasis symptom severity.

Habitual supplement use

Two studies explored supplement use of PLwP compared to controls, over a 30-day period. These had mixed results, in the US no significant difference in supplement use was found between PLwP (n=184) and matched controls (n=6027) (59). Whereas in Iran, a significantly higher proportion of PLwP (n=138) used supplements over the previous 30-day period, compared to controls (n=138). However, no difference was reported between supplement use and psoriasis severity (58).

Table 2: Summary of included studies under Theme 1: Dietary Intakes of People Living with Psoriasis

Authors, Year, Reference	Study Region	Study Design	Population Characteristics	Control Group	Significant Findings
Polo et al. 2020 [50]	Brazil	Cross-sectional FFQ used for dietary intake assessment, PASI used to assess psoriasis severity	PLwP: n = 94, 57% female, mean age 54.9 years, mean PASI 5.3	N/A	2 dietary patterns were identified: Pattern 1 - processed and Pattern 2 - fresh food. In people with psoriasis, women (p=0.006) and those with higher income (p=0.003) were more likely to follow dietary pattern 2 - fresh food. Inverse association with adherence to Pattern 2 and cutaneous activity.
Yazdanpanah et al. 2021 [51]	Iran	Cross-sectional FFQ used for dietary intake assessment, PASI used to assess psoriasis severity	PLwP: n= 45, 16 male, 29 female, mean age 40.4 years, mean BMI 26.92, mild-severe psoriasis severity	Non-psoriasis: n = 43, sex- and age matched	Compared to controls, PLwP had higher intakes of carbohydrates, fats, fibre, energy, vitamin E and folate ($p<0.05$). In the psoriasis group, higher dietary intake of fibre and vitamin E was significantly associated with lower disease severity ($p<0.05$).

Ingkapairoj et al. [52]	Thailand	Cross-sectional FFQ used for dietary intake assessment, PASI used to assess psoriasis severity	PLwP: n = 100, 47 males, 53 females; mean age 45·87 years, mild-to-severe psoriasis severity	Non-psoriasis: n = 100, sex- and age-matched	PLwP consumed significantly more dairy products (p = 0·017), coconut milk (p = 0·14) and soft drinks than controls (p = 0·004). Those with lower psoriasis severities consumed significantly more vegetables. A higher consumption of red meat, belly meat and instant noodles was associated with greater psoriasis severity.
Afifi et al. 2017 [45]	USA	Cross-sectional NHANES 2009–2010 dietary screening questionnaire (FFQ) used for dietary intake assessment, self-reported psoriasis severity.	PLwP: n = 1206 psoriasis,73·3% female, mean age 50·4 years, psoriasis severity: 20·9% mild, 42·2% moderate, 36·9% severe	Non-psoriasis: n = 2847, age- and sex-matched. From NHANES 2009–2010 dietary screening questionnaire.	PLwP consumed significantly less sugar, whole grain fibre, dairy and calcium (p < 0·001), and consumed significantly more fruits, vegetables and legumes (p < 0·01)

Kashani et al. [53]	Iran	Cross-sectional FFQ used for dietary intake assessment, ED-II used to assess dietary inflammation score and PASI used to assess psoriasis severity.	PLwP: n = 75, mean age 56·96 years, 48 males, 27 females, mean BMI 25·8 kg/m2	Non- psoriasis: n = 74, age-, sex- and BMI-matched	P LwP consumed significantly more fat (p ≤ 0·001),MUFA (p ≤ 0·001), PUFA (p = 0·0013), linoleic acids (p = 0·007), linolenic acids (p = 0·004), vitamin A (p = 0·001), calcium (p < 0·001) and iron (p = 0·001) compared with controls. A high E-DII score (pro-inflammatory diet score) was associated with increased severity of psoriasis as measured by the PASI.
Johnson et al.[54]	USA	Cross-sectional NHANES 2003–2006 dietary screening questionnaire (FFQ) used to assess dietary intake	PLwP n= 156	Non-psoriasis: n = 6104 from the NHANES 2003–2006 dietary screening questionnaire	PLwP consumed significantly less sugar compared with controls (p = 0·04).
Yamashita et al. [55]	Japan	Cross-sectional: Self-administered diet history questionnaire (BDHQ), based on Japanese diet used to assess dietary intake (FFQ), PASI used to assess psoriasis severity	PLwP: n = 70, 46 males, 24 females	Non-psoriasis: n = 70, age- and sex-matched	In the psoriasis group, those with a higher psoriasis severity (PASI) consumed a significantly higher amount of confection (p = 0·03).

Barrea et al. 2015 [56]	Italy	Cross-sectional 7-day 24-hour dietary recall used to assess dietary intake, PASI used to assess psoriasis severity	PLwP: n=41, plaque psoriasis, 100% male, treatment- naive.	Non-psoriasis: n= 41, age-, sex- and BMI-matched	Compared to controls PLwP had higher consumption of total and simple carbohydrates, total fat, PUFAs, n-6:n-3 PUFA ratio, cholesterol; lower consumption of protein, complex carbohydrates, MUFAs, n-3 PUFAs and fibre (P< 0.034). In PLwP higher MUFA consumption was associated with lower psoriasis severity (P< .001); Lower psoriasis severity was associated with lower total energy intake, saturated fatty acids, total PUFAs, n-6 PUFAs, n-6:n-3 PUFA ratio, simple carbohydrates and with higher n-3 PUFAs, MUFAs, fiber, complex carbohydrates (P< 0.007).
Wilson, 2014 [59]	USA	Cross-sectional NHANES 2009 to 2010 dietary screening questionnaire used to assess supplement use	PLwP: n= 184	Non-psoriasis: n= 6027 from NHANES 2009 to 2010 dietary screening questionnaire.	No significant difference in dietary supplement use between controls and those with psoriasis over the past 30 days (P = 0.416)
Wasiluk et al. 2012 [57]	Poland	Cross-sectional 3 x 24-hour dietary recall used to assess dietary intake, PASI used to assess psoriasis severity	PLwP: n= 39, 22 males and 17 females.	People with other chronic inflammatory skin disorders: n=18, 8 males, 10 females	In PLwP fat intake exceeded the recommended daily intake and fibre intake was far lower than the recommended daily intake. Males and females with psoriasis consumed more monounsaturated fatty acids than controls.

Supplement Use of People Living with Psoriasis					
Wilson, 2014 [59]	USA	Cross-sectional NHANES 2009 to 2010 dietary screening questionnaire used to assess supplement use	PLwP: n= 184	Non-psoriasis: n= 6027 from NHANES 2009 to 2010 dietary screening questionnaire.	No significant difference in dietary supplement use between controls and those with psoriasis over the past 30 days (P = 0.416)
Yousefzadeh et al. 2017 [58]	Iran	Cross-sectional Survey on supplement use over last 30 days, PASI was used to assess psoriasis severity	PLwP: n= 138, plaque psoriasis, age 20 - 91 years	Non-psoriasis: n= 138, age >20 years	Compared to controls, a significantly higher proportion of PLwP used supplements over the 30 days (72.5% vs 25.4%; P= 0.01). In psoriasis participants no significant difference was reported between supplement use and psoriasis severity.

FFQ, food frequency questionnaire; PASI, psoriasis area and severity index; PLwP, people living with psoriasis; BMI, body mass index; E-DII, Energy-adjusted Dietary inflammatory Index; NHANES, US National Health and Nutrition Examination Survey; BDHQ, Japanese diet history questionnaire based on diets in Japan.

2.5.2 Theme 2: The perceived role of diet in the management of psoriasis

This theme comprises studies which explored the perceived role and use of diet in the management of psoriasis. Five studies were identified under this theme (44,45,60–62), all of which were cross-sectional surveys and focused soley on the perceptions and experiences of people living with psoriasis (PLwP), no studies exploring the perceptions of healthcare professionals (HCPs) were identified in this review. See Table 3.

Diet was perceived by the majority of PLwP to have an impact on their psoriasis symptoms in several studies. A survey on perceptions of dietary approaches to manage psoriasis of PLwP (n=200) found that 62% of respondents perceived that following a specific diet could improve psoriasis, and 38% perceived that consuming specific foods could improve psoriasis (62). A further study exploring dietary modifications and perceived effects on psoriasis symptoms over the past 2 years in PLwP (n=43) found that 88.37% of respondents reported an improvement of psoriasis symptoms following a change in eating habits (60). Although, Afifi et al. found that in PLwP (n=1206) 43.2% of respondents were not sure how diet affected their skin, 17.4% felt diet was slightly helping their skin, 16.7% felt diet was significantly helping their skin, and 2.2% reported that their skin condition was completely controlled by diet (45).

People living with psoriasis commonly reported that they had made changes to their diet, the majority of which were self-prescribed. Afifi et al. found that in PLwP (n=1206) most respondents (86%) reported using a dietary modification of some kind, of these 40% reported following a specific diet to help their psoriasis, but only 30.7% of those that had changed their diet had discussed diet with a dermatologist (45). A further study of 269 PLwP found that over half (52.2%) of participants had attempted between 1 - 4 dietary interventions, with 5.9% having tried > 5 different dietary interventions (61). This study also found that participants with 2 or more subtypes of psoriasis had tried following more diets or taking more supplements than those with only 1. Additionally, an online survey exploring the dietary perceptions of PLwP (n=50) found that most respondents (85%) reported that

they had not received any advice from HCPs on diet. Overall, 20% had changed their diet to help psoriasis, of these the majority (80%) had followed self-prescribed diets (44).

The dietary changes made by PLwP were often restrictive, either following elimination diets or removing specific foods from diets. Afifi et al. found that a higher number of PLwP reported removing foods from their diets than those that reported trialling dietary additions (45) . Only three studies reported on specific dietary modifications trialled by PLwP and perceived symptom response. The most common dietary modification tried by PLwP reported across studies was reducing gluten or following a gluten-free diet (45,61). Further diets trialled by PLwP were vegetarian, paleolithic, ketogenic (61), Mediterranean, low carbohydrate high-protein and the Pagano diet alongside reducing or removing dairy (45). Common dietary components excluded were nightshades, alcohol and junk food (45). Dietary additions reported to have been trialled by PLwP were increased consumption of fruit, vegetables and fish as well as vitamin D, omega-3/fish oil and probiotic supplements (45,61).

The dietary modifications perceived to have a beneficial effect on symptoms were dairy free, vegan (45), vegetarian, paleolithic, the Pagano diet (45), the ketogenic diet, the Mediterranean diet (MD), and a gluten-free diet (GFD) (45,61). Reducing red-meat, gluten, nightshades, alcohol, and junk foods were also perceived to improve psoriasis skin symptoms by PLwP. (45,61). Respondents also reported improvement in skin symptoms after adding or increasing certain foods to their diet; fish, fruit and vegetables and supplements, specifically, omega-3, vitamin D and probiotics (45,61). A further study in PLwP (n=43) found that the majority (88.37%) of respondents reported an improvement of psoriasis symptoms following a dietary change (60). However, the study did not specify which dietary changes were perceived to make a difference. The positive aspects reported after changing diet were reduction of erythema and scaling, milder outbreaks, delay in the onset of lesions, and improved quality of life (60).

Dietary components were also perceived to be able to negatively affect psoriasis symptoms, in a study on those with moderate-severe psoriasis with a psoriasis area and

severity index (PASI) >5 (n=200), 46% perceived that foods could worsen psoriasis, specific foods identified by participants were sausages, dairy products, tomatoes, spicy food, chocolate and fried food (62). However, Afifi et al. reported that 37% of respondents reported that they did not recognize any dietary triggers which may worsen their psoriasis (45).

Popular literature

To be comprehensive, this review searched all diets and dietary modifications reported to have been tried by PLwP that were identified in the literature under theme 2, that had not been identified in the initial searches. PubMed and SCOPUS were searched using Psoriasis AND each of the diets or dietary modifications tried, using the same inclusion and exclusion criteria as described in the methods. No additional relevant results were found on PubMed or SCOPUS. This indicates that most of the diets that PLwP try, as reported in theme 2, have not been substantiated with any scientific evidence in relation to psoriasis management.

Table 3: Summary of included studies under Theme 2: The perceived role of diet in the management of psoriasis

Authors, Year, Reference	Study Region	Study Design	Population Characteristics	Findings
Festugato et al. 2011 [60]	Brazil	Cross-sectional Survey	PLwP: n= 43	88.37% reported and improvement of psoriasis symptoms following a change in eating habits (eating habits were not specified). The positive aspects reported were reduction of erythema and scaling, milder outbreaks, delay in the onset of lesions, and improved quality of life.
Pham et al. 2021 [44]	France	Cross-sectional Online survey	PLwP: n= 50	85% reported to have received no advice from HCP on diet; 20% had changed their diet to help psoriasis, of these the majority (80%) had followed self-prescribed diets.
Afifi et al. 2017 (45)	USA	Cross-sectional Survey Psoriasis severity was self reported	PLwP: n=1206, mean age 50.4 years, psoriasis severity: 20.9% mild, 42.2% moderate, 36.9% severe	86% reported use of a dietary modification, but only 30% had discussed diet with their doctor. 40% of participants had tried a specific diet for their psoriasis. The percentage of participants reporting skin improvement was greatest after reducing alcohol (53.8%), gluten (53.4%), nightshades (52.1%), junk foods (50.4%) and after adding fish oil/omega-3 (44.6%), vegetables (42.5%), and oral vitamin D (41%). In diets tried a favourable skin response was reported following the Pagano (72.2%), vegan (70%), and Palaeolithic (68.9%).

Dhinsa et al. 2021 (61)	USA	Cross-sectional Survey	PLwP: n=269, mild-severe psoriasis	52.2% of participants had attempted between 1 - 4 dietary interventions, 5.9% had tried > 5; participants with 2 or more subtypes of psoriasis tried more diets or supplements than those with 1 type. The percentage of participants reporting skin improvement was greatest after following ketogenic, (9 of 18 participants [50%]), Mediterranean (6 of 13 [46%]), vegetarian (6 of 15 [40%]), and gluten-free (9 of 25 [36%]) diets. The most commonly tried supplements were oral vitamin D, fish oil and probiotics. Probiotics reported the most positive skin response, as well as vitamin D and fish oil
Del Giglio et al. 2012 (62)	Italy	Cross-sectional Survey	PLwP: n=200, mean age 53 years, plaque psoriasis, moderate – severe psoriasis (PASI >5)	62% of respondents perceived that following a specific diet regimen could improve psoriasis; 38% of respondents perceived that certain foods could improve psoriasis, with the majority identifying fruits and vegetables (60%) as having a beneficial effect on psoriasis and fish (10%); 46% perceived that foods could worsen psoriasis, with specific foods identified being sausages (20%), dairy products (8%), tomatoes (8%), spicy food (7%), chocolate (7%) and fried food (5%).

PLwP, people living with psoriasis; HCP, healthcare professional; PASI, psoriasis area and severity index;

2.5.3 Theme 3: Dietary approaches for managing psoriasis symptoms

This theme included studies that explored specific dietary approaches and their impact on psoriasis symptoms. Dietary approaches were defined as specific dietary modifications followed to try and alleviate psoriasis symptoms through peer-reviewed investigations. See Table 4.

The findings are presented under each relevant sub-theme.

1. Specific diets
2. Dietary supplementation
3. Alternative dietary approaches

1. Specific diets in the management of psoriasis

This review found that a handful of specific diets had been studied regarding the management of psoriasis; Low-calorie diets (LCDs), very low-calorie ketogenic diets (VLCKD), intermittent fasting (IF), the Mediterranean diet (MD) and gluten-free diet (GFD).

Low-calorie diets (LCDs)

Low-calorie diets (LCDs) are dietary interventions that restrict energy intake with the goal of weight-loss. All LCD studies identified were conducted in people living with psoriasis (PLwP) who were living with obesity or overweight, defined as a BMI ≥ 25. Diets prescribed ranged from 500Kcal-1600 Kcal/ day. This review did not include studies on the impact of medication, exercise, or surgery for weight-loss on psoriasis severity.

The beneficial effect of LCD on psoriasis severity in subjects with obesity is supported in recent systematic reviews (46,63). A Cochrane review of lifestyle changes in the treatment of psoriasis identified 6 randomised control trials (RCTs) that evaluated the effects of a low-calorie diet in 499 participants with obesity (64). The review found that low-calorie diets may lead to an improvement ≥ 75% from baseline Psoriasis Area and Severity Index in PLwP with obesity, compared to usual care. However, more RCTs with larger sample sizes are needed. The Cochrane review meta-analysis also found that known risk factors of the

associated comorbidities of psoriasis were significantly reduced in the LCD group compared to the control groups at week 16 (65–68).

Several RCTs have found that LCDs significantly improve psoriasis severity in subjects who are living with overweight or obesity compared to controls (65,66). Improvement in severity was also seen in an observational study at 12-weeks (69). Only one study explored the long-term impact of a LCD on psoriasis severity and found that after 48 weeks, weight loss in patients with psoriasis continued to have positive effects on symptom severity (70).

However, a LCD followed by participants with obesity (BMI ≥ 30) for 24 weeks found no significant difference in PASI scores between the LCD group and the control (62). However, baseline BMI was higher than in other studies and the intervention LCD group may not have lost enough weight to produce the beneficial effect. In another study, although the LCD and control groups did not show a statistically significant difference in severity, the trend was towards reduced severity (67).

Very Low-Calorie Ketogenic Diet (VLCKD)

The main requirement to be defined as a ketogenic diet is carbohydrate restriction. In the studies identified in this review, the ketogenic diets also contained a very low energy content (300-500 Kcals/day) and were only conducted in PLwP with obesity or overweight. No systematic reviews on VLCKD and psoriasis symptoms were identified in this review. Three studies were identified that had explored the effects of a VLCKD on psoriasis severity (71–73).

A single-arm open label trial (n=37) found that weight-loss following a VLCKD (<500 kcal/d; 1.2 g of protein/kg of ideal body weight/d) for 4 weeks, followed by a balanced LCD (25-30 kcal/kg of ideal body weight/day) for 6 weeks significantly improvement in psoriasis area and severity index (PASI) and itch severity (72) in drug-naïve adults with an overweight BMI and stable plaque psoriasis. Castaldo et al 2021 explored the effect of a 4-week VLCKD of <500 kcal/day, providing 10–20 g of carbohydrates (from vegetables, 400–500 g/day), 20–30 g of lipids, and 1.4g per kg of ideal body weight of protein per day, on the psoriasis severity of participants (n=30) with overweight or obesity (73). After 4-weeks there was a

significant improvement in PASI, itch severity and dermatology life quality index (DLQI) (p=<0.05). However, no significant difference in weight-loss compared to baseline was reported at 4-weeks (73) . One case study of a female with severe psoriasis and obesity following a VLCKD (71) was also identified. Following a psoriasis relapse after treatment, the patient was put on a VLCKD of a protein-based enteral nutrition liquid of approximately 300 kcal/day, containing a protein content of 1.2 g/kg of ideal body weight, for 4-weeks. Compared to baseline, the patient lost 11kgs, and a significant reduction in psoriasis severity was observed (>80% PASI) after 4-weeks.

Mediterranean Diet (MD)

The Mediterranean Diet (MD) is typically high in fruits and vegetables, legumes, wholegrains, fish, nuts, and monounsaturated fatty acids (MUFA) such as extra-virgin olive oil (EVOO). With a moderate intake of meat, dairy, and alcohol (74). Four studies explored MD in the management of psoriasis (74–77). These were all cross-sectional studies that assessed the association between a score reflecting adherence to the MD and psoriasis severity. The higher the score, the higher the adherence to a MD. No randomised control trials (RCTs) were found to have been conducted on MD and psoriasis severity. Three of the studies also compared MD adherence of PLwP compared to controls (56,74,75).

Controls presented a significantly higher adherence to a Mediterranean diet compared to PLwP in all three case-control studies identified (74–76). Barrea et al. (76) found that psoriasis participants exhibited statistically significant differences compared with controls, in the consumption of certain individual MD dietary components. Controls consumed significantly more EVOO, fruit, fish and nuts and significantly less red meat than those with psoriasis (76).

Regarding psoriasis severity and MD adherence, those with less severe psoriasis had a higher adherence to a Mediterranean diet in all 4 studies. Barrea et al. (76) used PREDIMED score to assess MD adherence in people with mild to severe psoriasis (n=62). The study concluded that that PREDIMED score was a major predictor of psoriasis severity determined by PASI (p=0.007). Individual MD components were also shown to have an

independent predictive value for PASI score, higher consumptions of EVOO ($p<0.001$) and fish ($p=0.005$) were significantly associated with lower psoriasis severity scores (76). A summary of individual foods associated with higher or lower psoriasis severity can be seen in Table 5.

A large national-cross sectional study in PLwP in France (n=3557) found that a higher percentage of participants with severe psoriasis had a MEDI-LITE score of 0 to 7 (low adherence to the Mediterranean diet) compared to those without severe psoriasis. Mediterranean diet score was also found to be negatively correlated with PASI ($P = 0.001$) (74). In a smaller study (n=69) using MedDietScore to assess MD adherence in PLwP, MedDietScore was a significant negative predictor of PASI ($P = 0.02$) adjusting for age, gender, BMI. Higher consumption of legumes, fish, and EVOO ($P < 0.05$) were found to be associated with lower PASI scores, whereas higher dairy product consumption was positively correlated with psoriasis severity ($P = 0.002$) (75). The severity of psoriasis was lower in participants with greater adherence to the Mediterranean diet assessed using PASI ($p=0.007$), body surface area (BSA) ($p=0.009$) and practitioner global assessment (PGA) ($p=0.01$) in a further cross-sectional study on PLwP using PREDIMED questionnaire to assess adherence to the Mediterranean diet (77).

Gluten-free diet (GFD)

A gluten-free diet (GFD) eliminates gluten, a protein found in wheat, barley, and rye. Psoriasis is associated with an increased risk of coeliac disease, compared to the general population (78,79). Coeliac disease is a chronic condition affecting the small intestine, which is activated by the consumption of gluten. Studies suggest that psoriasis and coeliac disease share common genetic and inflammatory pathways (78). Gluten-specific serum antibody levels followed by a biopsy is used to diagnose coeliac disease. In those without a coeliac disease diagnosis, gluten-specific antibodies are higher in PLwP compared to controls. However, whether there is an association between higher antibody levels and greater psoriasis severity is unclear (78).

Two systematic reviews on diet and psoriasis found that a GFD may be beneficial in reducing psoriasis severity in those with coeliac disease or gluten-specific antibodies (63,78). From the findings of their review, Bhatia et al. recommended that healthcare professionals (HCPs) screen psoriasis patients for symptoms of gluten sensitivity, followed by gluten specific antibody tests (78). Those with positive antibody tests should then be advised to trial a GFD for symptom management (78). However, there was no suggestion on the length of GFD trial.

Several studies have shown the beneficial impact of following a GFD on psoriasis severity in participants with coeliac disease or gluten-specific antibodies. A study on psoriasis patients (n=39) with elevated gluten-specific antibodies showed a significant decrease in mean PASI score after 3-months on a GFD compared to a control group (80). Those with moderate-to-severe psoriasis showed an even greater PASI reduction than those with mild psoriasis. The control group consisted of PLwP but without coeliac disease or gluten specific antibodies, who also followed a GFD. In this group there was no change in disease severity, and in 2 participants there was a substantial worsening of psoriasis severity.

A further study by (81), found that PLwP who had high levels of gluten specific antibodies (n=8) (IgA against gliadin peptides) saw a 36% improvement in PASI score following a GFD for 1-year. Those with higher levels of gluten-specific antibodies (n=5) saw an even greater improvement, 56% reduction in PASI, following a GFD for 1 year. A GFD also significantly improved psoriasis symptoms in 9 patients with coeliac disease compared to baseline at 3-months and was maintained at 6-months (82). Complete clearance of psoriatic skin symptoms following a GFD for 1-month has also been reported in individual case studies (83,84). However, this data is based on small, uncontrolled studies.

One study found no improvement in psoriasis severity after 6-months of following a GFD in 3 patients with coeliac disease or gluten-specific antibodies (85). However, this was another small uncontrolled study.

Intermittent fasting (IF)

More recently intermittent fasting has been studied in the management of psoriasis. Two studies have explored this dietary approach, using fasting during Ramadan to explore the effects on psoriasis (86,87).

Almutairi & Shaaban 2022 assessed the effects of Ramadan fasting on psoriasis severity of 121 people with stable chronic plaque psoriasis in Kuwait (86). Participants followed traditional Ramadan fasting for 1 month, which consists of refraining from eating, drinking, or smoking during daylight hours. Participants consumed 2 main meals a day, one before sunrise and one after. At 1 month, no participant recorded any weight-loss, but mean PASI was significantly reduced compared to baseline (88). A further study (87) also investigated the impact of Ramadan fasting on psoriasis severity in participants with moderate-severe psoriasis (n=108). Following the month of fasting, a significant reduction in mean PASI score was observed compared to baseline (87).

One pilot study exploring the effects of modified intermittent fasting, the 5:2 diet (consuming normally for 5 days and restricting calorie intake on 2 non-consecutive days) on psoriasis severity was also found (89). Preliminary study findings presented at the European Academy of Dermatology and Venerology Spring Symposium, show a significant reduction in scaling and thickness in patients with mild psoriasis after following a 5:2 diet (89).

Other diets

Vegetarian, vegan and plant-based diets have been discussed in the literature as diets with potential to help alleviate psoriasis symptoms (90,91). However, this is based on the assumptions that following these diets would result in increased consumption of fruits, vegetables and antioxidants and the reduced consumption of saturated fats (90). Whilst cross-sectional studies have shown that following a MD, which is characterised by high fruit and vegetable consumption and low saturated fat intake, could help lessen psoriasis severity (74,76), this is not the same as following a vegan or vegetarian diet. Following a vegan, vegetarian and plant-based diet does not always result in increased fruit and

vegetable consumption. So far, no studies have been undertaken explicitly exploring vegetarian, vegan or plant-based diets in the management of psoriasis.

2. Supplementation in the management of psoriasis

Several supplements have been studied in the management of psoriasis; omega-3 polyunsaturated fatty acids (PUFA), Vitamin D, Selenium, B vitamins and probiotics.

Omega-3 Polyunsaturated Fatty Acids (PUFAs)

Several recent systematic reviews and meta-analysis have been conducted to evaluate the effects of omega-3 PUFA supplementation on psoriasis severity, with conflicting results. Most studies gave omega-3 PUFAs as fish oil supplements.

A systematic review based on 13 randomised control trials (RCTs) and a meta-analysis of 3 RCTs found that fish oil supplementation did not significantly reduce the severity of psoriasis assessed by psoriasis area and severity index (PASI) compared to controls. Concluding that the current evidence does not support the use of fish oil supplement in treating psoriasis (92). This was in line with a previous systematic review (93).

Another systematic review found that supplementation with fish oil omega-3 PUFAs alone had no effect on PASI score. However, when combined with traditional psoriasis treatments, a significant reduction in PASI score was observed compared to controls (94).

In contrast, a recent 2019 meta-analysis found that supplementation of omega-3 PUFAs did significantly reduce PASI score. Significant improvements in specific psoriasis skin symptoms, erythema, itching, and scale, were observed in trials which used higher doses of omega-3 PUFA supplementation (>1800mg/day) (95). The positive effects of high doses of omega-3 on psoriasis symptoms were in line with a recent study on the effect of Herring Roe Oil (HRO) on psoriasis severity (96). A significant improvement in mean PASI score with HRO supplementation of 2600mg eicosapentaenoic (EPA) / docosahexaenoic (DHA) per day, was observed compared to placebo treatment, at week 26. The authors of this study theorised that the beneficial effects of HRO were due to its EPA and DHA acids ratio of 3:1, compared to omega-3 PUFAs from fish oils, which is typically 1:1.

Omega-3 PUFA supplementation has been shown to have beneficial effects on the comorbidities associated with psoriasis (97).

Vitamin D

Topical vitamin D is a widely used treatment for plaque psoriasis (2). Lower levels of serum vitamin D have been reported in psoriatic patients compared to controls (98,99). A small, but significant, inverse correlation between serum 25(OH)D and the severity of psoriasis has also been reported (100,101). Hence, the interest in oral vitamin D and psoriasis management.

So far, studies have shown mixed results on the effectiveness of oral Vitamin D supplementation in the management of psoriasis. Systematic reviews have found no clear evidence to support vitamin D supplementation in the management of psoriasis symptoms (43,63,102). A recent meta-analysis found that a favourable effect of oral vitamin D supplementation in patients with psoriasis could not be verified (103). However, more RCTs are required to confirm these conclusions. There is evidence indicating that vitamin D supplements for the treatment of psoriasis should not be prescribed in participants with normal serum levels of vitamin D (104). It is unclear from the literature whether those with deficient or insufficient vitamin D levels have an improved skin response compared to those with optimal levels.

A RCT assessing the effect of oral vitamin D2 on psoriasis severity, found that D2 supplementation significantly increased the serum vitamin D level and significantly improved PASI scores in patients with psoriasis compared to the placebo group at 3months. There was no significant difference in baseline serum 25(OH)D vitamin D between groups, and some vitamin D insufficiency was seen in both groups (105). In a study that gave high doses of oral vitamin D3 (35,000 IU/day) to PLwP (n=9) and low vitamin D status (≤ 30 ng/mL), significant improvements in psoriasis severity were observed at 6-months compared to baseline (106). However, this was a small, uncontrolled study and participants were also required to follow a low-calcium diet (excluding dairy) over the course of the study. A further study also found a significant improvement in PASI score in

participants given oral vitamin D supplement of 50,000 IU / week for 3 months alongside usual treatment compared to the control group who just received usual treatment (107).

However, several RCTs have shown no beneficial effect of oral vitamin D supplementation on psoriasis severity. No significant difference was found in people with mild psoriasis over 12-months of vitamin D3 supplementation, or in those with plaque or moderate-to-severe psoriasis over 3-months compared to controls (108,109).

A recent series of case studies showed complete control of psoriasis with a high daily dose of 30,000 IU of vitamin D3 over a period of 2–6 months. Only 2 participants presented with severe vitamin D deficiency and were given a one-off loading dose of 600,000 UI vitamin D, all others had optimal levels (110). Other uncontrolled studies have also indicated that oral vitamin D supplementation for ≥ 6-months can significantly improve PASI score (103).

Epidemiological studies have demonstrated a strong association between vitamin D insufficiency and risk of several psoriasis associated comorbidities, including cardiovascular disease (CVD) and metabolic syndrome (111).

B Vitamins

Vitamin B12 deficiency has been associated with psoriasis (112). However, studies so far have focused on intramuscular doses of vitamin B12 and have been shown to be ineffective. Two systematic reviews on dietary approaches to psoriasis did not recommend vitamin B12 supplementation in the management of psoriasis due to the lack of studies (43,63). Vitamin B12 is an important cofactor in the metabolism of homocysteine, elevated levels of which have been associated with increased risk of CVD (113). This review also found one ongoing RCT on the effect of high doses of Vitamin B2 (riboflavin) on psoriasis severity, that is yet to be published (114).

Selenium

Reviews have not found any significant improvement in psoriasis severity with selenium supplementation (43,63,115,116). A small number of studies have evaluated the effect of selenium supplementation on psoriasis severity (115–117). One study found a significant

beneficial effect of selenium on PASI score compared to controls. However, the supplement was combined with coenzyme Q-10 and vitamin E (117).

Probiotics

Recent studies have drawn attention to the role that the gut microbiome plays in the pathogenesis of dermatological conditions, including psoriasis (118). Psoriasis is associated with inflammatory bowel disease (IBD), and studies have shown that the gut microbiome is altered in psoriasis compared to controls (119,120). It has also been reported that patients with moderate-to-severe psoriasis have a lower gut microbial diversity than patients with mild disease (121). As a result, probiotic supplementation has become a recent research focus in the management of psoriasis.

A systematic review on the effectiveness of probiotic supplements in psoriasis found that probiotics significantly reduced PASI scores in psoriasis compared to controls after 12 weeks of supplementation and may be an effective treatment for alleviating psoriasis symptoms. However, these findings were based on only 2 RCT studies that explored probiotic supplementation and PASI, and larger-scale RCTs are needed to confirm this (122).

Several studies have shown probiotic supplementation to have a beneficial effect on psoriasis severity (123–127). A recent RCT found that consuming a probiotic drink containing lactobacillus strains for 8-weeks significantly reduced PASI and psoriasis symptom scale (PSS) scores compared to the placebo group (124). A further double-blind placebo-controlled trial (n=46) found that after 8 weeks of multi-strain probiotic oral supplementation PASI and quality of life scores had significantly improved compared to the placebo group (127). Additionally, single-arm trial (n=27) reported significant reduction in PASI compared to baseline at 12 weeks of probiotic supplementation (126). One case study also reported that supplementation of a probiotic containing Lactobacillus strains had a strong alleviating effect on skin symptoms in a patient with pustular psoriasis after 15 days. The patient continued with probiotic supplementation, and after 6-months psoriasis severity had reduced further (128).

3. Alternative dietary approaches in the management of psoriasis

This review identified several studies that explored alternative dietary approaches in the management of psoriasis. These were defined as non-traditional dietary approaches. The majority of which were small studies. One cross-sectional questionnaire was identified that explored the use of complementary alternative methods used by people living with psoriasis (PLwP), this study found that health supplements were reported by 21.2% to be helpful for psoriasis, the most popular health supplements taken were: aloe (17%), chlorella (13.6%) and green tea (13.6%) (129) .

Several small studies have been conducted on oral curcumin, a phytochemical found in the spice turmeric, and psoriasis severity, with mixed results (130–132). A review of the RCTs suggested that more studies are need on the effects of oral curcumin on psoriasis severity before any conclusions can be made (131).

The impact of oral Nigella Sativa (NS) on psoriasis severity in 60 participants with mild-moderate psoriasis was investigated in an RCT. Participants were given an oral dose of NS (500mg three times daily) for 12 weeks, at 12 weeks psoriasis area and severity index (PASI) score had decreased from baseline (133). However, whether this was significant or not was not clear. One RCT investigated oral capsules containing alga D. bardawil, a natural source of the retinoid precursor 9-cis β-carotene, in participants with mild plaque psoriasis (n=34) (134). Participants received capsules of the alga or a placebo, and at 6weeks, the reduction in the mean PASI score was significantly higher in the alga group compared to the placebo group ($p = 0.002$).

The association between coffee consumption and severity of psoriasis was evaluated in a cross-sectional study of treatment naïve PLwP (n=221). Coffee consumers were found to have a significantly lower PASI score compared to non-consumers ($p < 0.001$), with the lowest PASI score seen in those consuming 3 cups of coffee/day, and the highest PASI score was found among those drinking ≥ 4 cups/day (135).

2.5.4 Grey Literature

The relevant grey literature sources identified and included in this review included reports, guidelines and other materials produced by a range of stakeholders in psoriasis management. Most of the grey literature identified, regarding psoriasis management, provided no dietary guidance for people living with psoriasis (PLwP), and most did not mention the word diet or nutrition at all. In those that did mention diet, the vast majority focused on weight-loss and dietary approaches for comorbidities associated with psoriasis. For example, the National Institute for Heath and Clinical excellence (NICE) guidelines for psoriasis assessment and management mention reducing alcohol intake and losing weight, but only as modifiable risk factors for associated comorbidities (136). Several sources did provide further information regarding diet specific to psoriasis symptom management. The National Psoriasis Foundation (NPF) in the United States (US) conducted a systematic review on the dietary recommendations for adults with psoriasis in 2018 (63). Based on this, they recommend weight-loss in PLwP with obesity or overweight as the only evidence-based dietary approach for psoriasis management on their website and suggested that a gluten-free diet (GFD) could provide relief in those with coeliac or gluten sensitivity. Several grey literature resources provided warnings about diets that claim to 'cure' psoriasis and misinformation that can be found online and included evidence-based dietary advice. However, overall, there was a lack of advice on who to go to for dietary support, the health impacts and the risks associated with following restrictive diets that claim to help psoriasis and guidance for following a restrictive diet.

Table 4: Summary of included studies under Theme 3: Dietary approaches in the management of psoriasis symptoms

Authors, Year, Reference	Study Design	Population Characteristics	Control Group	Findings
Low-calorie diets (LCDs)				
Ko et al. 2019 [64]	Cochrane Systematic Review and Metanalysis	N/A	N/A	6 RCTs examined the effects of LCDs in 499 subjects with obesity. Compared to usual care, dietary intervention (strict caloric restriction) may lead to 75% or greater improvement from baseline in the Psoriasis Area and Severity Index (PASI 75). Dietary intervention may reduce the severity of psoriasis (low quality evidence) and probably improves quality of life and reduces BMI (moderate-quality evidence) in participants with obesity when compared with usual care.
Debbaneh et al. 2014 [46]	Review on the Impact of weight loss interventions on psoriasis	N/A	N/A	Weight-loss reduced BMI led to improved PASI and DQLI for participants with obesity or overweight with psoriasis.
Gisondi et al. 2008 [66]	RCT PLwP treated with cyclosporine alongside a LCD vs PLwP treated with cyclosporine alone for 24 weeks.	PLwP: n=30, 15 females, 15 males, moderate-severe psoriasis	PLwP: n=31, 15 males, 16 females, moderate severe psoriasis	Weight loss improved the response of patients with obesity and moderate-to-severe chronic plaque psoriasis to low-dose cyclosporine therapy: A reduction of 75% of PASI response was achieved by 66.7% of participants following a low-calorie diet and by 29.0% of patients treated with cyclosporine alone ($P < 0.001$).

Jensen et al. 2013 (67)	RCT The intervention group received an LCD (800–1000 kcal/d) for 8 weeks to induce weight loss, followed by 8 weeks of reintroduction of normal food intake, reaching 1200 kcal/d. Control group followed routine diet for 16 weeks	PLwP: n = 30, subjects with obesity BMI >27 kg/m2, moderate psoriasis	PLwP: n = 30, subjects with obesity BMI >27 kg/m2, moderate psoriasis	The LCD group lost significantly more weight than the routine diet group ($p < 0{\cdot}001$). LCD group achieved a greater reduction in PASI ($p = 0{\cdot}06$) and greater improvement in DQLI ($p = 0{\cdot}02$) compared with control group.
Jenson et al 2016 (70)	Follow-up study of RCT (Jensen et al. 2013 (67)) 2 periods: the LCD period (16 weeks) followed by weight-loss maintenance period (48 weeks)	PLwP: n = 30, subjects with obesity BMI >27 kg/m2, moderate psoriasis	PLwP: n = 30, subjects with obesity BMI >27 kg/m2, moderate psoriasis	Changes in the severity of psoriasis (PASI and DLQI) were maintained after 48 weeks.
Del Giglio et al (62)	RCT LCD or free diet (control) for 24 weeks, followed up for an additional 12 weeks	PLwP: n = 22, subjects with obesity BMI ≥30 kg/m2, moderate-to-severe psoriasis	PLwP: n = 20, subjects with obesity BMI ≥29 kg/m2, moderate- to-severe psoriasis	No significant difference in PASI scores between the LCD group and the control group.

Guida et al. 2014 (68)	RCT The intervention group followed an LCD of 20 kcal/kg/d that was n-3 polyunsaturated fatty acids rich	PLwP: n = 22, subjects with obesity BMI ≥30 kg/m2, mild-to-severe psoriasis	PLwP: n = 20, subjects with obesity BMI ≥30 kg/m2, mild-to-severe psoriasis	At 3 and 6 months, PASI was significantly reduced in patients in the LCD high n-3 PUFA group compared with controls ($p < 0{\cdot}05$), as well as itch scores ($p < 0{\cdot}05$).
Al-Mutairi et al. 2014 (65)	RCT LCD (≤ 1000 kcal per day) for 8 weeks. PASI was used to assess severity, scores were assessed at baseline and every 4 weeks up to 24 weeks.	PLwP: n=131, subjects with obesity, receiving biologic therapy	PLwP: n=131, subjects with obesity, receiving biologic therapy	At week 24, mean weight loss was significantly higher in the LCD group compared to the control group. A reduction in PASI of 75% was achieved by a significantly higher percentage of the LCD (85.9%) compared with the control group (59.3%) ($p < 0.001$).
Castaldo et al. 2021 (72)	Open label single arm study. 4-week very-low-calorie (<500 kcal/day) protein based diet providing 10– 20 g of carbohydrates (from vegetables, 400– 500 g/day), 20–30 g of lipids, and 1.4 g per kg of ideal body weight of protein per day. PASI was used to assess psoriasis severity, VAS was used to assess itch severity, and DLQI was	PLwP: n=30, 11 males and 19 females, subjects with obesity or overweight >25 BMI, mean BMI 30.82 kg/m2, mean age 42.8 years, mean PASI 8.69, plaque psoriasis.	N/A	At 4-weeks, no significant difference in weight-loss compare to baseline. A significant improvement in PASI, VAS itch severity and DLQI was reported (p=<0.05) compared to baseline.

	taken to assess quality of life.			
Castaldo et al. 2020[72]	Open label single arm study. 10-week 2 phase weight-loss programme: 4-week protein-sparing, <500 kcal/day, followed by 6-week balanced hypocaloric, low glycaemic index, Mediterranean-like diet (25-30 kcal/kg of ideal body weight). PASI was used to assess psoriasis severity, VAS was used to assess itch severity, and DQLI was taken.	PLwP: n=37, subjects with overweight or obesity >25 BMI, mean BMI 31.7 kg/m2, drug naive, mean PASI 13.8, chronic moderate severe plaque psoriasis.	N/A	At week 10: a significant reduction in body weight, PASI score, and itch severity and DLQI (p=<0.001) compared to baseline.
Castaldo et al. 2016 [71]	Case study First stage: 4 weeks VLCKD (~300kcal/day). Second stage: hypocaloric Mediterranean-like diet at low glycaemic index for 6 weeks.	PLwP: n=1, female, 40 years old, subjects with obesity BMI 35 kg/m2, severe plaque psoriasis.	N/A	At 3 months a complete remission and improved response to biologics following diet regime. Compared to baseline the participant experienced a significant weight loss (92kg vs 67.4 kg), improvement in PASI (15 vs 0.3) and DLQI score (12 vs 1).

Mediterranean Diet (MD)				
Phan et al. 2018 [74]	Prospective, web-based questionnaire study of respondents from the French NutriNet-Santé cohort. A Mediterranean diet adherence score (MEDI-LITE) was calculated for each participant using the average of 3–15 24-h dietary records gathered during the first 2 years after inclusion	PLwP: Severe psoriasis n = 746, 76·9% females, mean age 46·8 years Non-severe psoriasis n = 2308, 72·1% female, mean age 48·3 years	Non-psoriasis: n = 27 828, 76·6% females, mean age 47·8 years	Patients with severe psoriasis displayed low levels of adherence to the Mediterranean diet. Patients with severe psoriasis had a higher risk of having a MEDI- LITE score of 0–7 (low adherence to the Mediterranean diet) compared with patients with non-severe psoriasis and patients without psoriasis.
Barrea et al. 2015 [76]	Cross-sectional PREDIMED 14-item questionnaire, was used to assess adherence to the Mediterranean diet, PASI used to assess psoriasis severity	PLwP: n = 61 patients, 49 males and 13 females, mean age: 50·2 years, mild-to-severe psoriasis.	Non-psoriasis: n = 61 age-, sex- and BMI- matched.	A higher percentage of PLwP had a low or average adherence compared with the control group (30·6% versus 4·8%, $p < 0·001$ and 51·7% versus 77·5%, $p = 0·004$, respectively). No significant differences in those with a high PREDIMED score (17·7% versus 17·7%).
Molina-Leyva et al. 2019 [77]	Cross-sectional PREDIMED 14-item questionnaire was used to assess adherence to the Mediterranean diet, PASI, BSA, PGA and subjective responses were used to assess psoriasis severity.	PLwP: n= 89, mild-severe psoriasis,	N/A	Psoriasis severity was lower in participants with greater adherence to the Mediterranean diet for all measurements, PASI - p=0.007, BSA - p=0.009, PGA - p=0.01, subjective - p=0.004.
Korovesi et al. 2019 [75]	Cross-sectional	PLwP:	Non-psoriasis: n= 69, age-, sex-,	Compared to PLwP controls presented a higher adherence to the Mediterranean diet (P = 0.01) with a

	MedDietScore was used to assess adherence to Mediterranean diet. PASI and DLQI was used to assess severity of psoriasis.	n= 69, 35 men, 34 females, treatment naive, mean age 47.7 years, mean BMI of 28.9 kg/m2, moderate-severe psoriasis, mean DLQI of 9.5.	BMI-matched	higher MedDietScore (P < 0.001). MedDietScore correlated negatively with PASI (P = 0.001) and DLQI (P < 0.001). MedDietScore was a significant negative predictor of PASI (P = 0.02) and DLQI (P = 0.06 of borderline significance) adjusting for age, gender, BMI, and hsCRP. Specific items of the MedDietScore were inversely associated with psoriasis severity; legumes, fish, and EVOO (P < 0.05). PASI positively correlated with dairy products (P = 0.002)
Gluten-free diet (GFD)				
Bhatia et al. 2014 (78)	Review and meta-analysis	N/A	N/A	a gluten-free diet may potentially be beneficial in coeliac antibody positive psoriasis patients, but additional studies are needed to confirm this.
Michaëlsson et al. 2003 (80)	RCT GFD followed 3-month period. Blood samples were drawn at baseline and at 3 and 6 months for assays of serum levels of IgA AGA and IgG AGA. PASI was used to assess psoriasis severity.	PlwP: n = 37, 31 with IgA and/or IgG AGA, 6 without IgA and/or IgG antibodies to gliadin (IgA AGA and/or IgG AGA), 15 females, 22 males, mean age 45.13 years.	N/A	At 3 months 73% of those with psoriasis with IgA and/or IgG AGA had a lower PASI score. Participants with elevated IgA AGA and/or IgG AGA showed a significant decrease in their mean PASI score after 3 months on a GFD. Of the six patients without AGA there was no change in two and a pronounced deterioration in four after following a GFD for 3 months.
Addolorato et al. 2003 (83)	Case study	PLwP:	N/A	Rapid regression of psoriasis after gluten-free diet.

		n=1, coeliac disease not responding to usual treatment.		
Kolchak et al. 2018 [81]	Observational GFD for 1-year in PLwP with positive gliadin IgA antibodies, PASI was used to assess severity	PLwP: n=13, 27-56 years old, PASI > 2.4	N/A	Improvement of psoriatic lesions was observed in all patients with positive gliadin IgA antibodies. PLwP who had high levels of gluten specific antibodies (n=8) (IgA against gliadin peptides) saw a 36% improvement in PASI score following a GFD for 1-year. Those with higher levels of gluten-specific antibodies (n=5) saw an even greater improvement, 56% reduction in PASI, following a GFD for 1 year.
De Bastiani et al. 2015 [82]	Observational GFD for 6 months	PLwP: n=8, positive for anti-tissue transglutaminase antibodies diagnosis of CD was confirmed histologically	N/A	At 6 months GFD was associated with a significant improvement of skin lesions in 7 out of 8 participants with psoriasis.
Zamani et al. 2010 [85]	Case Study GFD for 6 months	PLwP: n=3; 1 female, 2 males, mean age 28.3 years, 2 with increased IgA tissue transglutaminase antibodies, 1 with confirmed CD.	N/A	No improvement in psoriasis severity after 6-months of following a GFD in 3 patients with coeliac disease or gluten-specific antibodies.
Intermittent fasting (IF)				
Almutairi & Shaaban, 2022 [86]	Observational Ramadan fasting for 1 month (2 main meals/ day, one before sunrise and one	PLwP: n=121, stable chronic plaque psoriasis, mean PASI score of 4.36	N/A	Mean PASI was significantly reduced compared to baseline (p = 0.001). No significant difference in weight change in 102 (84.30%) patients, 14 (11.57%) gained 1 kg and 5 (4.13%) gained 2 kg. However, no patient recorded loss of weight.

	after, refrain from eating or drinking during daylight hours, smoking and sex), PASI and BSA scores were used to assess psoriasis severity.			
Damiani et al. 2019 [87]	Observational Ramadan Fasting for 1 month (2 main meals/ day, one before sunrise and one after, refrain from eating or drinking during daylight hours, smoking and sex), PASI was used to assess psoriasis severity.	PLwP: n= 108, 62 males, 46 females, mean age 42.84 ± 13.61 years, moderate severe plaque psoriasis	N/A	Significant reduction in mean PASI score after 1 month of Ramadan fasting compared to baseline (p=0.0001).
Omega-3 Polyunsaturated Fatty Acids (PUFAs)				
Yang et al. (2019) [92]	Meta-analysis of randomised controlled trials	N/A	N/A	13 RCTs with 625 participants were identified, 3 RCTs involving 337 participants provided usable data for meta-analysis. Fish oil supplement did not significantly reduce the severity of psoriasis when assessed by Psoriasis Area and Severity Index score compared with control groups. The current evidence does not support the use of fish oil supplement in treating psoriasis
Upala et al. 2017 [93]	Systematic review	N/A	N/A	12 studies were included, findings are inconclusive on whether use of n-3 PUFA in patients with psoriasis is associated with improvements in severity of symptoms.
Chen et al. 2020 [94]	Systematic review	N/A	N/A	18 RCTs found monotherapy with fish oil n-3 PUFA had no effect on PASI score. Fish oil n-3 PUFA combined with conventional treatments resulted in a decreased PASI score.

Clark et al. 2019 [95]	Meta-analysis of	N/A	N/A	10 studies involving 560 participants were included in the meta-analysis. The meta-analysis indicated a significant reduction in PASI score in favour of n-3 PUFA group. The random effects model showed a statistically significant beneficial effect of n-3 PUFA supplementation on reducing erythema and scaling
Tveit et al. 2020 [96]	RCT Double-blind, placebo-controlled clinical study Dietary supplement containing HRO (3:1 DHA-to-EPA ratio) 292 mg PUFA, total daily does was 2·6 g EPA/DHA and 5·9 g lipid or placebo for 26 weeks. Participants were instructed to stop supplements of cod liver oil, n-3 PUFA and choline for 4 weeks prior to study. PASI was used to assess psoriasis severity	PLwP: n = 32, 15 females, 17 males, mean age 47 years, mean PASI 6, BMI 29·54 kg/m2	PLwP: n = 32, age-, sex-, PASI-, BMI-matched	A statistically significant improvement in the mean PASI score in HRO supplementation group compared with placebo group at 26 weeks. No significant differences were observed at earlier visits (weeks 6, 12 and 18).
Vitamin D				
Theodoridis et al. 2021 [103]	Systematic review and meta-analysis of efficacy of oral vitamin D supplementation in lessening disease severity of patients with psoriasis.	N/A	N/A	4 studies were included in the analysis. A favorable effect of oral vitamin D supplementation in patients with psoriasis could not be verified. More randomized controlled trials with larger sample sizes are needed to produce robust results.
Stanescu et al. 2022 [102]	Review Oral Vitamin D Therapy in Patients with Psoriasis	N/A	N/A	Findings suggest that more large-scale studies are needed to determine the efficacy, optimal dose, and adverse effects of vitamin D administration in patients with psoriasis.

Finamor et al. 2013 (106)	Open-label intervention study Vitamin D3 35,000 IU / day for 6 months alongside A low-calcium diet (avoiding dairy products and calcium enriched foods like oat, rice or soya "milk") and hydration (minimum 2.5 L daily.	PLwP: n=9, all patients presented low vitamin D status (serum 25(OH) D3 ≤ 30 ng/mL) at baseline.	N/A	At 6 months 25(OH)D3 levels significantly increased. PASI score significantly improved in all 9 participants.
Al-Sultany et al. 2020 (107)	Comparative therapeutic study Oral vitamin D supplement of 50,000 IU / week for 3 months alongside topical potent corticosteroid (clobetasol propionate) compared with control of just topical potent corticosteroid (clobetasol propionate). PASI was used to assess psoriasis severity and vitamin D serum level.	PLwP: n= 38, 13 females, 25 males, mean age 34.63 years old, mean BMI 26.82+5.4 kg/m2, moderate-severe Plaque-psoriasis (PASI). Oral vitamin D (50,000 IU weekly dose for 3 months	PLwP: n=38, age-, BMI-, PASI-score, baseline vitamin D level-matched. usual treatment of topical potent corticosteroid (clobetasol propionate)	At 3 months a significant increase in serum vitamin D levels and significant improvement in PASI score was seen in participants in the Vitamin D group compared to control group (p =0.033).
Disphanurat et al. 2019 (105)	RCT A Double-Blind, Placebo-Controlled Study Oral vitamin D2 supplementation 60,000	PLwP: n=23, 13 females, 11 males, mean age 52.39 years, mean PASI 4.68, mean BMI 26.3 kg/m^2	PLwP: n=22, age-, sex-,	At 3 months, the oral vitamin D2 group had significantly higher PASI improvement than the placebo group

	IU/2 weeks or placebo for 6 months.			
Jarret et al. 2017 (108)	RCT Double-blind, placebo controlled, vitamin D3 supplementation of 100,000 IU/ month for 12 months	PLwP: n=23, 50-84 years,	PLwP: n=42, age-, PASI-, serum vitamin D level-matched	At 12 months, no significant difference in psoriasis severity (PASI) was observed between vitamin D group and control group.
Ingram et al. 2018 (109)	RCT Double-blind, placebo controlled, vitamin D3 supplementation of 100,000 IU/ month for 12 months.	PLwP: n=67,	PLwP: n=34, age-, PASI-, serum vitamin D level-matched	PASI did not differ between groups at any time. However, 25(OH)D increased in both groups, rendering these findings inconclusive
Mahtani et al. 2022 (110)	Case series Oral Vitamin D3 supplements 30,000 IU/day for 2-6 months. Those with severe vitamin D deficiency were given a one time loading dose of 600,000 IU vitamin D followed by 30,000 IU Vitamin D3 / day. PASI was used to assess psoriasis severity.	PLwP: n=6, 5 females, 1 male, aged 37-63 years, severe psoriasis.	N/A	Complete control of psoriasis in each participant over a period of 2–6 months.

B Vitamins				
Unpublished				
Selenium				
Serwin et al. 2003 (115)	Placebo-controlled trial 00 µg of selenium daily as selenomethionine or placebo alongside topical treatment with 5% salicylic acid ointment, 0·1–0·3% dithranol ointment for 4 weeks	PLwP: n=11	PLwP: n=11	No significant difference in PASI at 4 weeks.
Serwin et al. 2006 (116)	Placebo-controlled trial 200 µg of selenium daily as selenomethionine or placebo alongside narrowband ultraviolet B therapy and for 4 weeks. Assessment at baseline, 2 weeks, 4 weeks, and 4 weeks post-study.	PLwP: n=19	PLwP: n=18	No significant difference in PASI at any time point.
Kharaeva et al. 2009 (117)	A double-blind placebo clinical study Oral supplementation with coenzyme Q 10 (ubiquinone acetate, 50 mg/d), vitamin E (natural α-	PLwP: n = 14, 6 females, 8 males, mean age	PLwP: n = 14, sex-, age-matched, severe erythrodermic	Supplementation resulted in significant improvement of PASI score in supplementation group compared with control.

	tocopherol, 50 mg/d) and selenium (aspartate salt, 48 µg/d) dis- solved in soy lecithin or a placebo of soy lecithin for 30–35 d	36·2 years, severe erythrodermic psoriasis	psoriasis	
Probiotics				
Zeng et al. 2021 (122)	A Systematic Review and Meta-Analysis of Randomized Controlled Trials and Preclinical Trials	N/A	N/A	2 studies found. Probiotics can improve PASI, however more studies are required.
Atabati et al. 2020 (125)	Review	N/A	N/A	1 study on probiotic supplementation and psoriasis severity identified. Probiotics may have ameliorating effects on psoriatic skin. Larger controlled studies are needed.
Lin et al. 2021 (126)	Single-arm, open-label preliminary clinical trial 12-wk supplementation of oral probiotics Bacteroides fragilis BF839, compared to baseline at 4, and 12 weeks.	PlwP: n=27, 18 males and 9 females, aged between 22– 67 yrs, mean PASI 9.1±5.9, mild severe psoriasis vulgaris.	N/A	Mean PASI at 12 weeks significantly lower ($P < 0.01$) compared to baseline.
Navarro-Lopez et al. 2019 (123)	RCT Double-blind, placebo controlled trial. 12-week supplementation of 3 probiotic strains in 1:1:1 ratio or placebo freeze-dried powder with	PLwP: n=46, aged 18-70 years, plaque	PLwP: n=44, plaque psoriasis, mild moderate psoriasis	At 12-weeks, 66.7% of patients in the probiotic group and 41.9% in the placebo group showed a reduction in Psoriasis Area and Severity Index of up to 75% ($p < 0.05$). At 6 months, a lower risk of psoriasis relapse after the intake of the probiotic mixture was seen compared to control.

	maltodextrin. PASI and PGA were evaluated at baseline, 2 weeks, 6 weeks and 12 weeks	psoriasis, mild moderate psoriasis		
Moludi et al., 2021 (124)	RCT Double-blin, placebocontrolled trial. 2 x Probiotic oral capsule 3 lactobacillus strains; multiLactobacillus acidophilus, Bifidobacteriumbifidum, Bifidobacterium lactis and Bifidobacterium langum with1.8109 colony forming units (CFU) a day for 8 weeks or placebo (maltodextrin) for 8 weeks. PASI, PSS and DQLI were measured at baseline.	PLwP: n=25, 18-50 years old, 60% female, mean PASI 10.65	PLwP: n=25, age-, sex-, PASI-matched.	At 8 weeks the probiotic group had a significantly reduced mean PASI score compared to the control group (10.65 ± 5.12 to 5.39 ± 2.73) (p=0.049) and a reduced mean DLQI (p=0.045) and PSS (p=0.047) score.
Vijayashankar & Raghunath 2012 (128)	Case study	PLwP: 1 female, 47 years, severe pustular psoriasis.	N/A	After 2 weeks of supplementation, psoriasis improved. At 6-month follow up (following same treatment) the patient is free of psoriatic lesions.
Moludi et al. 2022 (127)	RCT Double-blind placebo controlled clinical trial	PLwP:	PLwP:	At 8 weeks the probiotics group had significantly improved PASI score and quality of life.

	8 weeks of probiotic oral capsules containing multi-strain (Lactobacillus acidophilus, Bifidobacterium bifidum, Bifidobacterium lactis, and Bifidobacterium langum) 1.6x 109 CFU/g bacteria or placebo. PASI used to assess severity.	n=23, mild-severe psoriasis	n=23, mild-severe psoriasis, age-, sex, BMI- and PASImatched	
Alternative dietary approaches				
Gamret et al. 2018 [131]	Systematic Review	N/A	N/A	Treatment with oral curcumin, examined in 3 studies conferred statistically and clinically significant improvements in psoriasis plaques. Larger controlled studies are needed to confirm these findings.
Antiga et al. 2015 [130]	RCT Double-blind Meriva, a lecithin-based delivery system of curcumin at 2 g/day with usual topical steroid treatment, or with topical steroids alone for 12 weeks.	PLwP: n=31, 17 females, 14 males, aged 1962 years, mild-to moderate psoriasis vulgaris (PASI < 10)	PLwP: n=32, sex-, age- and PASI-matched	A significant decrease in PASI participants treated with both topical steroids and oral curcumin compared to participants treated only with topical steroids.
Ahmed et al. 2014 [133]	Open-label trial Supplementation of crude NS powder (500mg	PLwP: n=20,	N/A	At 12 weeks significant improvement in mean PASI score compared to baseline.

	capsule three times/day) for 12 weeks compared to baseline			
Greenberger et al. 2012 [134]	Prospective, randomized, double blinded pilot study Oral alga Dunaliella bardawil or placebo of starch powder capsules taken daily for 12 weeks. PASI was used to assess psoriasis severity.	PLwP: n=17, 6 females, 11 males, mean age 52 years, mean BMI 27 kg/m2	PLwP: n=11, 3 females, 8 males, age-, BMImatched	At 6 weeks the reduction in the mean PASI score was significantly higher in the alga Dunaliella bardawil group than in the placebo group (61.3% vs 34%, respectively, p = 0.002).
Barrea et al. 2018 [135]	Cross-sectional case-control observational	PLwP: n=221, treatment naive	N/A	Coffee consumers have a lower PASI score versus non-consumers (p < 0·001). The lowest PASI score were seen in participants consuming 3 cups of coffee per day (p < 0·001), which was also the most common daily serving (34·8%), whereas the highest PASI score was found among those drinking ≥4 cups per day.
Kurd et al. 2008 [132]	single-arm, non-controlled, open label clinical trial, Oral curcumin 4.5g/day.	PLwP: n=12	N/A	At 12 weeks a significant decrease in PASI from baseline (p=0.04)
Kim et al. 2013 (129)	Cross-sectional questionnaire on complementary and alternative supplementation used in PLwP	PLwP: n=189, 70 females, 119 males, mean age 42 years	N/A	17. 5% used health supplements as CAM to help psoriasis. Health supplements were reported by 21·2% to be helpful for psoriasis; the most popular health supplements taken were: Aloe 15 (17%), Chlorella12 (13·6%) and green tea (13·6%).

PLwP, people living with psoriasis; RCT, randomised control trial; BMI, body mass index, PASI, psoriasis area and severity index; DLQI, dermatology life quality index; LCD, low calorie diet; n-3 PUFA, omega-3 polyunsaturated fatty acid; VLCKD, very low-calorie ketogenic diet; MD, Mediterranean diet; EVOO, extra virgin olive oil; BSA, body surface area; PGA, physician global assessment; GFD, gluten-free diet; IgA, Immunoglobulin A; IgG AGA, Immunoglobulin G antigliadin antibodies; IF, intermittent fasting; HRO, herring roe oil; DHA, Docosahexaenoic acid; EPA, eicosapentaenoic acid; IU, international units; PSS, psoriasis severity scale; CAM, complementary and alternate methods; NS, nigella sativa

Table 5: Summary of individual foods included in the studies identified that were associated with lower or higher psoriasis severity.

Authors, Year, Reference	Study Design	Population Characteristics	Findings
		Associated with lower psoriasis severity	
Extra Virgin Olive Oil (EVOO)			
Barrea et al. 2015 [56]	Cross-sectional PREDIMED 14-item questionnaire, was used to assess adherence to the Mediterranean diet, PASI used to assess psoriasis severity.	PLwP: n= 61 patients, 49 males and 13 females, mean age: 50.2 years, mild-severe psoriasis.	Individual MD component: higher consumption of EVOO was associated with lower psoriasis severity (P <0.001).
Korovesi et al. 2019 [75]	Cross-sectional MedDietScore was used to assess adherence to Mediterranean diet. PASI and DLQI was used to assess severity of psoriasis.	PLwP: n= 69, 35 men, 34 females, treatment naive, mean age 47.7 years, mean BMI of 28.9 kg/m2, moderate-severe psoriasis, mean DLQI of 9.5.	Individual MD component: EVOO was inversely associated with psoriasis severity (P < 0.05).
Fish (non-specific)			
Barrea et al. 2015 [56]	Cross-sectional PREDIMED 14-item questionnaire, was used to assess adherence to the Mediterranean diet, PASI used to assess psoriasis severity.	PLwP: n= 61 patients, 49 males and 13 females, mean age: 50.2 years, mild-severe psoriasis.	Individual MD component: higher fish consumption was associated with lower psoriasis severity (P = 0.005).

Korovesi et al. 2019 [75]	Cross-sectional MedDietScore was used to assess adherence to Mediterranean diet. PASI and DLQI was used to assess severity of psoriasis.	PLwP: n= 69, 35 men, 34 females, treatment naive, mean age 47.7 years, mean BMI of 28.9 kg/m2, moderate-severe psoriasis, mean DLQI of 9.5.	Individual MD component: Fish was inversely associated with psoriasis severity ($P < 0.05$).
Legumes (non-specific)			
Korovesi et al. 2019 [75]	Cross-sectional MedDietScore was used to assess adherence to Mediterranean diet. PASI and DLQI was used to assess severity of psoriasis.	PLwP: n= 69, 35 men, 34 females, treatment naive, mean age 47.7 years, mean BMI of 28.9 kg/m2, moderate-severe psoriasis, mean DLQI of 9.5.	Individual MD component: Legume consumption was associated with reduced psoriasis severity ($P < 0.05$).
Vegetables (non-specific)			
Barrea et al. 2015 [76]	Cross-sectional PREDIMED 14-item questionnaire, was used to assess adherence to the Mediterranean diet, PASI used to assess psoriasis severity.	PLwP: n= 61 patients, 49 males and 13 females, mean age: 50.2 years, mild-severe psoriasis.	Individual MD component: Vegetables ≥2 servings/day negatively correlated with PASI ($p < 0.001$).
Ingkapairoj et al. 2022 [52]	Cross-sectional FFQ used for dietary intake assessment, PASI used to assess psoriasis severity	PLwP: n= 100, 47 males, 53 females; mean age 45.87 years, mild severe psoriasis severity	Frequently consuming vegetables (≥3 times/ week) was associated with lower psoriasis severity ($P = 0.02$).

Fruits (non-specific)			
Barrea et al. 2015 [76]	Cross-sectional n= 61 patients, 49 males and females, mean age: 50.2 years, mild-severe psoriasis. questionnaire, was used to assess adherence to the Mediterranean diet, PASI used to assess psoriasis severity.	PLwP: negatively correlated with PASI ($p < 0.001$). PREDIMED 14-item 13	Individual MD component: Fruits ≥3 servings/day
Associated with higher psoriasis severity			
Red meat			
Ingkapairoj et al. 2022[52]	Cross-sectional FFQ used for dietary intake assessment, PASI used to assess psoriasis severity	PLwP: n= 100, 47 males, 53 females; mean age 45.87 years, mild severe psoriasis severity	Frequently consuming red meat (≥3 times/ week) was associated with higher psoriasis severity (P = 0.01).
Dairy (non-specific)			
Korovesi et al. 2019 [75]	Cross-sectional MedDietScore was used to assess adherence to Mediterranean diet. PASI and DLQI was used to assess severity of psoriasis.	PLwP: n= 69, 35 men, 34 females, treatment naive, mean age 47.7 years, mean BMI of 28.9 kg/m2, moderate-severe psoriasis, mean DLQI of 9.5.	PASI positively correlated with dairy products (P = 0.002).
Confection (sugary sweet foods)			

Yamashita et al. 2019 (55)	Cross-sectional Self-administered diet history questionnaire (BDHQ), based on Japanese diet used to assess dietary intake (FFQ),	PLwP: n= 70, 46 males, 24 females	In the psoriasis group, those with a higher psoriasis severity (PASI) consumed a significantly higher amount of confection (P = 0.03).

PLwP, people living with psoriasis; BMI, body mass index, PASI, psoriasis area and severity index; DLQI, dermatology life quality index; VAS, visual analogue scale; MD, Mediterranean diet; EVOO, extra virgin olive oil; BSA, body surface area; FFQ, food frequency questionnaire.

2.6 DISCUSSION

In this study, we reviewed the current evidence on the role of diet in the management of psoriasis. We included all types of study designs that met the inclusion criteria, as well as relevant grey literature. This has enabled us to provide a comprehensive overview of the current evidence and a unique insight into the role of diet in the management of psoriasis regarding dietary intake of people living with psoriasis (PLwP), the use and perceived effectiveness of diet of PLwP and dietary approaches for psoriasis management. We reviewed 72 peer-reviewed studies as well as 77 relevant grey literature resources. The principal findings suggest that diet could play a role in psoriasis management, however, most evidence comes from small heterogenous studies. Therefore, specific psoriasis dietary guidelines and recommendations cannot be made. The breadth of this scoping review also enabled us to map the research gaps and highlight areas for future research, to be able to better understand the role that diet plays in psoriasis management and improve dietary support for PLwP. The results of this scoping review were organised into three themes, alongside the grey literature, the discussions for each theme are presented below.

Theme 1: Dietary Intakes of People Living with Psoriasis

The studies included in this review suggest that the dietary intakes of PLwP differ from that of controls. The studies frequently found PLwP to have higher dietary intakes of fat (51,53,56) and lower intakes of fibre (45,51,56) compared with controls. Studies also reported differences in intakes of sugar, dairy, pulses and legumes, vegetables and polyunsaturated fatty acids (PUFA) compared to controls. Furthermore, the evidence also suggests that the dietary intakes of people with less severe psoriasis differ from those with higher psoriasis severity.

High-fat diets (HFDs) have been shown to elicit low-grade systemic inflammation through elevated production of pro-inflammatory cytokines also seen in psoriasis, including interleukin (IL)-1β, IL-6, and tumour necrosis factor (TNF)-α. HFDs also play a key role in the development and progression of multiple diseases, including cardiovascular disease (CVD), type II diabetes, atherosclerosis, and some cancers (137). Murine studies have

found that HFDs exacerbate the imiquimod induced psoriasiform dermatitis in mice (138,139) and in both mice with obesity and lean mice, those fed with HFDs developed a more severe early psoriasiform skin inflammation (140). This suggests that increased fat consumption could play a role in psoriasis symptom severity. Information on the specific fats consumed was lacking in the studies included in this review and would provide more insight into the potential mechanisms behind these dietary intakes.

Several studies also reported that PLwP had lower intakes of fibre compared to controls, and in psoriasis populations lower intakes of fibre were seen in those with more severe psoriasis compared to those with lower psoriasis severity (51,56). Fibre has been shown to decrease levels of plasma inflammatory markers including c-reactive protein (CRP) and IL6, and TNF-α (141), which play a key role in the pathophysiology of psoriasis. Dietary fibre also has a beneficial effect on the gut microbiome, and through short-chain fatty acid production, produces immune and inflammatory regulation responses (141) . However, higher intakes of pulses and legumes, which are high in fibre, were reported in PLwP than in controls (45,55). Additionally, a gluten-free diet (GFD) is associated with reduced fibre intake. Following a gluten free diet in people with coeliac disease has been shown to improve psoriasis symptoms, and coeliac is seen more commonly in people with psoriasis compared to the general population (78). Following a GFD is also a common dietary modification trialled by PLwP (45,61), which could explain the difference reported in fibre intakes between PLwP and controls. Following a GFD was also frequently perceived to improve psoriasis symptoms by PLwP. However, these studies did not include information on the coeliac status of participants, and lack of information on types and sources of fibre make it difficult to compare results and understand the potential mechanisms of action. Furthermore, fibre intake is associated with relevant health impacts, has appetite regulating and anti-obesogenic effects, and higher intakes have been associated with lower systemic inflammation (142), consuming adequate amounts of dietary fibre is also associated with multiple health benefits, including reduced CVD risk (143). Therefore, understanding the fibre intake in PLwP is also important due to the associated comorbidities.

A significantly higher consumption of vegetables was reported in those with lower psoriasis severity compared to people with higher severity (52). Vegetables are key sources of vitamins and polyphenolic compounds which have antioxidant and anti-inflammatory properties (41,144,145). Flavonoids and carotenoids, polyphenolic compounds commonly found in vegetables, have been shown to enhance immune pathways and inhibit certain pro-inflammatory pathways (41) . Specifically relevant to psoriasis, they have been shown to reduce pro-inflammatory cytokines IL-6, TNF-α (41), which are involved in the pathophysiology of psoriasis (31). Vegetables are also important sources of dietary fibre (146). However, no studies identified specific vegetables consumed, so it is difficult to suggest potential pathways. Interestingly, Afifi et al. found that PLwP had a higher intake of fruits and vegetables compared with controls (45). This could be attributable to people with psoriasis following popular psoriasis dietary recommendations, which typically suggest that fruits and vegetables can improve psoriasis symptoms. This review has shown that dietary modifications among PLwP to try and manage psoriasis are common (45,61). Dietary changes after diagnosis or to manage symptoms may also explain the contradictory findings regarding sugar, dairy and fish intakes of PLwP compared to controls. Removing or reducing dairy and sugar as well as following a vegetarian diet are recommended as dietary approaches to manage psoriasis in popular literature.

Two studies found that total polyunsaturated fatty acid (PUFA) intake was significantly higher in PLwP compared to controls (53,56). Although, when assessed on PUFA type, Barrea et al. found that n-3 PUFA intake was significantly lower in PLwP compared to controls, and lower intakes were associated with higher severity (56). n-3 PUFAs are potentially potent anti-inflammatory agents (147). However, this was a small study conducted in treatment-naïve males, therefore, generalisability and comparability are limited.

Although the studies identified suggest dietary intake is different in PLwP and controls and between those with different severities, the evidence is limited. This review identified 9 studies that have only been conducted in 7 countries worldwide. All of the studies were cross-sectional and most had sample sizes under 200 people. Additionally, the methodologies varied substantially between studies which impair the ability to be able to

compare results between studies. Most of the studies used food frequency questionnaires (FFQs) to assess dietary intakes of participants, that although useful in these types of studies, rely on self-reported information, participant memory, perceptions on portion sizes, and foods may be missed if not presented on FFQ lists. It is also difficult to focus on the effect of one dietary component, as diet is a complex combination of different nutrients (148) and multiple other lifestyle factors can impact the development and severity of psoriasis (1). Longitudinal population-based studies are needed to further investigate a causal role between dietary intake and psoriasis, and effects on severity in PLwP. However, the studies identified in this review give an insight into the dietary intakes of PLwP and highlight important research gaps. Furthermore, the differences in dietary intakes could also impact general health and prompt further research in PLwP, due to the associated comorbidities that could also be exacerbated by the dietary intakes highlighted here, in particular, high fat and low fibre intakes (149).

Theme 2: The Perceived Role of Diet in the Management of Psoriasis

The belief that diet impacts psoriasis symptoms is common in PLwP, and many adjust their diets accordingly. However, most PLwP do not discuss diet with their healthcare professional prior to making dietary changes. This is concerning considering that most of the dietary changes tried were restrictive. This study also searched the scientific literature for evidence on the dietary approaches trialled by PLwP reported in the studies found under Theme 2. Except for the Mediterranean diet (MD) and GFD no studies were identified that had explored the use of any of the dietary approaches reportedly followed in the management of psoriasis. This suggests that most dietary approaches tried by PLwP are unsubstantiated, self-prescribed and taken from the popular literature. Following fad-diets long-term or restrictive diets without the guidance of healthcare professionals (HCPs), can result in micronutrient deficiencies (MND) (150,151). Micronutrient deficiencies have been reported in people with irritable bowel syndrome (IBS) who self-prescribe elimination diets, without consulting HCPs (150,152). Elimination diets could also result in further health impacts. Following a GFD was a common dietary modification trialled by PLwP (45). A GFD has been shown to be lower in dietary fibre and some essential micronutrients which have protective properties, such as the cholesterol lowering and improved glycaemic control

(149), relevant to PLwP considering the associated comorbidities. Additionally, gluten-free foods are often more expensive (153). Furthermore, restrictive diets have also been linked to reduced quality of life (QoL), disordered eating and orthorexia (152).

The most common dietary modifications reported to improve psoriasis were reducing dairy, gluten, nightshades, alcohol and sugar. Apart from alcohol, and gluten in those with coeliac and gluten sensitivity, the mechanisms of how reducing these specific dietary components could improve psoriasis are unclear and have not been researched. Theories suggest that the potential pro-inflammatory impact of sugar consumption could be the reason behind this effect, high amounts of dietary sugars have been shown to promote T-cell-mediated inflammation (154). Dairy is commonly demonized in popular literature as being pro-inflammatory, most likely due to the saturated fat and lactose content of certain dairy products (155). However, a recent systematic review found that dairy products and dairy proteins have neutral to beneficial effects on biomarkers of inflammation (155). Nightshades are plants from the Solanaceae family, which include potatoes, tomatoes, peppers and aubergines, they contain solanine and alkaloids which have been linked with inflammation (45). However, no association between nightshades and inflammation is supported by scientific studies in humans. Furthermore, they are high in nutrients beneficial to health.

Overall, the evidence is limited, only five studies were identified under this theme, in this review (44,45,60–62) all of which were cross-sectional surveys which relied on self-reported information and memory. Participants may have been more likely to have an interest in diet or believe that diet helps manage their psoriasis, which may have impacted results. Additionally, sample sizes were small, with only two studies with a sample size over 200, most participants were white females, and no studies included information on other factors known to affect psoriasis severity, including stress and smoking. Despite the limitations of these studies the findings highlight important factors to consider in psoriasis care, as well as highlighting important research gaps.

Studies exploring the perceived role of diet in the management of psoriasis have only been conducted in 4 countries worldwide. None have been conducted in the U.K and this

represents an important research gap as over 1.1 million people in the U.K are estimated to be living with psoriasis. Instagram and online forums are commonly used by people with acne to seek information on nutritional suggestions to help their skin condition (156). However, no studies identified explored the sources of dietary information of PLwP or content of recommended dietary changes. Only 3 of the studies provided information on specific dietary modifications made. Further understanding the dietary recommendations suggested in the popular literature and duration of diets trialled could help HCPs understand the potential impact on nutrient status and ways to support PLwP. Following restrictive diets long-term can lead to micronutrient deficiencies (150,151). Furthermore, specific symptom responses to dietary modifications have not been investigated. It was commonly reported that most PLwP do not discuss diet with a HCP prior to making dietary changes (44,45,60), understanding the reasons behind this will give insight into patient support needs and enable HCP to better understand how to assist PLwP. Another notable gap in the literature are studies exploring the perceptions of HCPs involved in psoriasis management on the role of diet.

Theme 3: Dietary Approaches to Manage Psoriasis

The strongest evidence for dietary methods in the management of psoriasis symptoms is for low-calorie diets (LCDs) in subjects with obesity or overweight. The link between obesity and psoriasis is well recognised (3,157). Several studies have demonstrated a relationship between increased BMI and increased psoriasis severity (46,63,64). Excess bodyweight is also associated with increased incidence of psoriasis (157,158) and reduced response to psoriasis treatments (159). The relationship is theorised to be a result of increased pro-inflammatory cytokine release due to increased adipose tissue. Weight reduction in subjects with obesity reduces adipose tissue and consequently, inflammation (65). Limited research has been conducted on ketogenic diets and psoriasis. Two open label single arm studies (72,73) and one case study (71) were identified in this review, all of which used very low-calorie ketogenic diets, between 300-500Kcals/day and were only conducted in subjects with obesity or overweight. Although significant improvements in psoriasis severity were observed in these studies (71–73) it is currently unclear whether this was due to the very low-calorie content or the specific ketogenic properties (protein-

based diet with low-carbohydrate intake) of the diets followed. Further RCTs are needed to fully assess the additional benefits of VLCKD versus other non-ketogenic diets with the same calorie intake. This is in line with conclusions of a narrative review on nutritional management of VLCKD in psoriasis (160). Furthermore, no studies have been conducted on ketogenic diets in PLwP without overweight or obesity.

A gluten-free diet (GFD) in coeliac or gluten sensitive populations of people with psoriasis also seems to have a beneficial effect on symptom severity. Overall, evidence suggests that psoriasis patients with gluten-related antibodies may benefit from a GFD, however, larger trials are still lacking (81). Additionally, it should be acknowledged that not all people living with psoriasis are also living with obesity, overweight, or have a sensitivity to gluten. This leaves a large proportion of patients without any evidence based dietary advice. A recent Cochrane review highlighted the need for more studies on the effects of diets other than LCDs on psoriasis severity, dietary interventions in people without obesity, and in people with mild psoriasis (64).

A greater adherence to a Mediterranean diet (MD) shows a positive trend in helping to manage psoriasis. This dietary pattern is anti-inflammatory and is associated with significant reductions in both IL-6 and IL-1β levels (161), key pro-inflammatory cytokines in psoriasis (31) . Which may explain the reason for these findings. Certain individual foods components of the MD (extra-virgin olive oil, fruit, vegetables, and fish (76)) have been associated with lower psoriasis severity (see Table 5). The MD is a dietary pattern typically high in fruits and vegetables, legumes, wholegrains, fish, nuts, and monounsaturated fatty acids (MUFA) such as extra-virgin olive oil (EVOO), with a moderate intake of meat, dairy, and alcohol (74) shown to have anti-inflammatory effects (161) . Dietary patterns are complex combinations of foods and nutrients that act synergistically, they account for inter-relations of foods, represent the cumulative exposure to different diet components, and may have stronger effects on health than any single component (162,163) . Therefore, it is difficult to attribute effects to single dietary components (162–165). It is also important to note that these findings are based on cross-sectional studies, which cannot establish a cause-and-effect relationship between adherence to the Mediterranean diet or its' individual components and psoriasis severity.

Regarding supplementation, high doses of Omega-3 with an increased eicosapentaenoic (EPA): docosahexaenoic (DHA) ratio of 3:1 have shown potential for alleviating psoriasis symptoms (96). A higher ratio of EPA:DHA is associated with further reductions in C reactive protein (CRP) compared to lower ratios (166), CRP is a pro-inflammatory biomarker shown to be elevated in psoriasis (36). Which could go some way in explaining the beneficial effect seen in higher ration supplementation. Probiotic supplementation also shows promising results for alleviating psoriasis symptoms; however the studies identified for the review were small and heterogenous. Additionally, limited evidence is available on long-term follow ups, specific strain, amount, dosage or duration of consumption for probiotics. Overall, the evidence for dietary supplementation in managing psoriasis is inconclusive and no evidence on optimal dose for any supplement is apparent. Larger controlled studies are needed to elucidate any dietary approach that is helpful, specifically in PLwP without obesity and coeliac- or gluten sensitive-free populations. This is in line with findings from several systematic reviews on diet and psoriasis (63,122).

Grey Literature

Considering the limited evidence for specific dietary approaches for psoriasis management, it is understandable that there are no specific dietary guidelines for the management of psoriasis. This could also be the reason that most of the grey literature provides very limited dietary information specific to psoriasis management and instead focuses on dietary advice for associated comorbidities. However, this review has highlighted that despite the lack of guidelines PLwP do modify their diet to try and manage their psoriasis symptoms, often without consulting a healthcare professional (HCP) (44,45,61). The diets trialled are often restrictive and could have detrimental effects on health and wellbeing. Therefore, it is important for HCPs and PLwP to understand the potential harms of following restrictive diets, especially considering the associated comorbidities. Stakeholders and those responsible for providing support for PLwP should provide more specific guidance on the potential harms of popular diets, in particular highlighting the risks of following restrictive diets, dietary aspects to consider if following elimination diets and the importance of consulting a HCP regarding dietary modifications. However, this review has highlighted that there is limited research on the use of popular

diets and support that PLwP would like regarding diet. This is especially true for the U.K where even though there are an estimated 1.1 million PLwP , no studies were identified that have explored the perceived role of diet in the management of psoriasis, dietary information acquisition and dietary support wanted by PLwP in the U.K, which highlights an important research gap. Further understanding dietary information acquisition and advice being suggested could enable stakeholders to provide more support to PLwP by increasing awareness of the potential health impacts of following popular diets.

2.6 LIMITATIONS OF THE REVIEW

Although the search strategy and inclusion criteria used in this scoping review followed PRSIMA-ScR systematic methods for scoping reviews, there are several limitations. Only literature written in English was included, this could have excluded relevant studies and guidelines conducted in other languages. The challenges of searching for grey literature could result in bias and the reproducibility of grey literature searching is difficult. The strategy used to search grey literature in this review was based on the methodology of Godin et al. (48) and pre-defined targeted search terms were used to try and reduce bias and improve reproducibility, alongside using incognito mode during google searches. However, website searching is dependent on the specific website and correct functioning. Additionally, this review did not contact experts in the field of psoriasis management to ask for additional reports or unpublished studies they were aware of. This may have resulted in some relevant studies and grey literature being omitted. Including studies that investigated the nutritional status of PLwP may have also made this review more comprehensive.

Despite these limitations, this review provides a comprehensive summary of the current available evidence and grey literature regarding the role of diet in the management of psoriasis. This review goes beyond previous review articles on diet and psoriasis, by including grey literature, studies on the dietary perceptions of people living with psoriasis and systematically searching for common dietary modifications used by PLwP on PubMed and SCOPUS as they emerged from the literature.

2.7 CONCLUSION

This scoping review provides a comprehensive overview of evidence of the role of diet in the management of psoriasis. It is the first study to review such a wide evidence base on the role of diet in managing psoriasis; exploring the dietary intakes of people living with psoriasis (PLwP), perceptions and use of diet in PLwP, the dietary approaches and the grey literature on psoriasis management.

Overall, there is limited evidence on all themes identified in this review and the methodology and outcome measures of the studies identified vary widely. Dietary intakes of PLwP warrant homogenous longitudinal studies to elucidate a causal relationship between diet and psoriasis status. In the absence of dietary guidelines, PLwP are self-prescribing dietary modifications suggested in the popular literature. These are often restrictive and could have detrimental effects on health and wellbeing. No studies have been conducted on sources of dietary information for people with psoriasis. There is also an absence of studies investigating the effects of popular dietary recommendations on psoriasis symptoms, patient experience and the perceptions of healthcare professionals (HCPs) on the role of diet in managing psoriasis. None have been conducted in the UK.

Some dietary methods have been shown to improve psoriasis severity, but only in specific populations; low-calorie diets in people with obesity or overweight, and gluten-free diets in those with coeliac disease or gluten sensitivity. The evidence suggests that diets with anti-inflammatory properties, particularly the Mediterranean diet (MD), may have beneficial effects on psoriasis through moderating specific inflammatory pathways in psoriasis (42,161). However, this is based on cross-sectional studies (74–77) and larger intervention studies are needed before any cause and effect can be ascertained regarding psoriasis or psoriasis severity. Other dietary approaches lack high-quality evidence to support their use. Larger controlled trials in PLwP without obesity or overweight, and coeliac or gluten sensitive free populations are necessary prior to any dietary recommendations being made for psoriasis management.

Several studies identified in this review highlighted individual foods that were associated with psoriasis severity. However, it is difficult to attribute effects to single dietary components, as dietary patterns are complex combinations of foods and nutrients which

work synergistically (162,163). Caution should be used when singling out specific foods as 'good' or 'bad' for certain conditions, without a robust evidence base, as this is an oversimplification which may lead to unhealthy eating behaviours (164,165). Deleterious dietary recommendations should also consider the food that will be substituted as a result of cutting out specific foods (163–165). It is also important to note that these findings are based on cross-sectional studies, which cannot establish a cause-and-effect relationship between these individual foods and psoriasis severity.

In the absence of dietary guidelines or evidence-based dietary recommendations for psoriasis, nutritionists and healthcare professionals should provide dietary support to PLwP in other ways, beyond standard healthy eating guidance. This should include highlighting the potential negative impacts of popular restrictive diets and the importance of discussing dietary modifications with healthcare professionals with nutritional expertise.

Grey literature resources for HCPs and PLwP should provide more comprehensive advice on diet specific to psoriasis. This should include information on the risks of following restrictive or elimination diets and the importance of discussing dietary modifications with a HCP. However, to make this advice as beneficial as possible, further research is needed to understand dietary information acquisition of PLwP, commonly recommended diets in the popular literature and the perceptions of PLwP on the dietary support available. Understanding the role of diet in the management of psoriasis from HCPs point of view would also enable advice to be more comprehensive. With the significant comorbidities associated with psoriasis, understanding dietary behaviours, perceived skin response, information acquisition and patient experience will play a key role in holistic patient care for people with psoriasis.

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CHAPTER 3 QUALITATIVE EXPLORATION OF THE EXPERIENCES AND PERCEPTIONS OF DIET IN PSORIASIS MANAGEMENT AMONG UK ADULTS

CHAPTER SUMMARY

In this chapter, I present a published qualitative research study that analyses individual interviews with people living with psoriasis in the UK. Participants (n=9) were asked about their experiences and use of diet in managing their psoriasis, to explore in-depth the perceptions and experiences among adults with lived experience in the UK through qualitative methods. It is hypothesised that PLwP in the UK implement a wide range of unsubstantiated dietary modifications, which may be restrictive, to try and help alleviate psoriasis symptoms.

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CONTRIBUTIONS

Poppy Hawkins (PH) was involved in developing the methodology of the study, immersed herself in the data via listening to recordings and reading transcripts of each interview, multiple times, as well as meeting with the researcher who facilitated the interviews to further understand and familiarise herself with the data. PH also conducted data analysis using reflexive thematic analysis, presented and discussed identified themes with the fellow authors, and drafted the manuscript. Sarah Mason facilitated the interviews and discussed key themes with PH as they were identified from the thematic analysis. Rosalind Fallaize, Kate Earl and Athanasios Tektonidis contributed to the study design, discussions on key themes that arose and drafting of the manuscript. All authors included reviewed and approved the final manuscript.

3.1 ABSTRACT

Objective: This study aimed to explore the use, experiences and perceptions of diet in psoriasis management among adults with lived experience in the UK.

Design: Qualitative. Data was analysed thematically using a reflexive thematic approach.

Setting: Online discussions with adults living with psoriasis in the UK.

Participants: Nine adults (two men, seven women) ≥ 18 years of age, living in the UK, English speaking, with a diagnosis of psoriasis of any severity.

Results: Four key themes were generated: (1) Impact of diet, (2) Dietary modification (3) Dietary information and (4) Dietary support. Overall, the majority (n=8) perceived that diet had an impact on their psoriasis. Most participants (n=7) reported trying restrictive diets including dairy-free, gluten-free, and "cleanses" to help manage their psoriasis with limited success. A perceived lack of dietary support resulted in participants relying on social media and online forums for dietary information. Participants reported a high cognitive burden due to the lack of reliable nutrition guidance and insufficient dietary support from healthcare professionals (HCPs).

Conclusions: Participants rely on social media and online forums for dietary information, which suggest unsubstantiated restrictive diets, that could negatively impact health. Participants felt overwhelmed by dietary recommendations and wanted more relevant dietary support. In the absence of evidence-based dietary information for psoriasis, HCPs need to be able to provide basic dietary support and combat misinformation. Larger studies aimed at understanding how best to support people with psoriasis are needed.

Strengths and limitations

- The qualitative design of the study allowed for in-depth exploration and rich insight into the participant's experience.
- This study employed Braun and Clarke's reflexive thematic analysis, a flexible approach that allowed researchers to effectively capture and represent participants' reported experiences.
- Adherence to the Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist enhanced the quality, rigor and transparency of the study.
- The study provides valuable insights, but the findings are based on a small homogeneous sample, which may limit generalisability.

3.2 INTRODUCTION

Psoriasis is a chronic, immune-mediated, inflammatory skin disease associated with arthritic, cardiovascular, metabolic, and psychological comorbidities [1,2]. There are an estimated 60 million people living with psoriasis (PLwP) globally and in the UK approximately 2% of the adult population are living with psoriasis [3]. The chronic, painful and visible symptoms of the disease can have a substantial negative impact on quality of life (QoL) [4].

Research indicates that lifestyle can impact psoriasis symptoms [5,6]. Reducing alcohol [7], limiting stress [8] and smoking cessation [9] have been shown to improve psoriasis symptoms. Furthermore, obesity is more common in PLwP compared to controls, and a higher body mass index (BMI) is associated with increased psoriasis severity, attributed to adipose-driven inflammatory activity [10]. Current evidence on the role of diet in the management of psoriasis is limited to weight-loss in those living with overweight or obesity and a gluten-free diet (GFD) in those with coeliac or a gluten sensitivity [11,12]. There are no dietary guidelines for psoriasis, and there is high demand for information on diet from both HCPs and PLwP. The question 'Do lifestyle factors such as diet, dietary supplements, alcohol, smoking, weight loss and exercise play a part in treating psoriasis?' was identified as the top research priority for psoriasis by The James Lind Alliance Priority Setting Partnership [13]. However, research on the experiences of PLwP and their use and perceptions on the role of diet is scarce globally [11]. Emerging data suggests that PLwP trial restrictive diets without guidance from a healthcare professional (HCP), to try and help manage their psoriasis [14], which could lead to micronutrient deficiencies and negatively impact QoL [15,16]. There is a lack of data on the practices of PLwP, individuals with other skin conditions report using unregulated platforms including Instagram and online forums for nutritional advice to manage their condition [17].

No studies in the UK have explored the use of diet in PLwP, their experiences of dietary modifications, or sources they rely on in the absence of evidence-based dietary guidelines. With an estimated 1.1 million PLwP in the UK, this represents an important research gap. Exploring how PLwP use and perceive the impact of diet will play a key role in understanding the potential effect on both psoriasis and the health and well-being of PLwP,

crucial for providing holistic care for patients. This study aims to explore in-depth the experiences and use of diet in psoriasis management among adults with lived experience in the UK through qualitative methods.

3.3 METHODS

Due to the scarcity of literature on this topic among a UK population, an explorative qualitative study was undertaken to enhance understanding and provide in-depth insights. Consolidated Criteria for Reporting Qualitative Research (COREQ) a 32-item checklist for interviews and focus groups, was used to guide the reporting of the study findings [18], see Appendix 1.

3.3.1 Study design and participant recruitment

Qualitative semi-structured interviews were conducted with UK adults with psoriasis. Ethical Approval was granted by The University of Hertfordshire, Heath, Science, Engineering & Technology Ethics Committee with Delegated Authority research aLMS/SF/UH/04684(2). Participants were recruited online via Facebook. The study was posted in a private Facebook group for PLwP in the UK, which comprised of over 15000 members at the time of recruitment. Purposive sampling was employed to recruit participants. The eligibility criteria for this study were aged ≥ 18 years, currently living in the UK, English speaking, and a medical diagnosis of psoriasis of any severity. No incentive was advertised on the study recruitment post, however, following participation, participants were offered a £30 renumeration voucher for their time. Participant information and informed consent forms were emailed to each participant prior to undertaking the interview. At the start of the interview the interviewer went through all forms and obtained verbal informed consent. Participants were aware that the research team wanted to explore the perceptions of PLwP on diet.

Patient and public involvement

The design of this study was guided by the outcomes of previous cross-sectional questionnaires asking PLwP about their diet. The topic guide for the interviews in this study was informed by the responses given in these earlier studies. Patients were not involved in

the study's design, recruitment or completion. The results will be shared with the study participants and public through this publication.

3.3.2 Data collection

Semi-structured individual interviews with UK adults with psoriasis were conducted to explore the perceived role of diet in the management of psoriasis. Topic guides were developed by RF and SM (both female). RF is a registered dietitian and Associate Professor in Research at the University of Hertfordshire, with extensive experience in qualitative research. SM was a final year dietetics student with an interest in diet and psoriasis. The topic guides were used to ensure interviews were consistent, but participants were also encouraged to expand on answers and express their opinions freely. The topic guide is provided as an online supplemental file, see appendix 2. The interviewer asked participants to clarify answers and comments where meaning was unclear and frequently checked with participants whether their understanding of the meaning of their answers was correct. All interviews were conducted by one researcher (SM) with a single participant at a time. Each interview lasted approximately 1 hour, and all were conducted online via remote meeting applications, Microsoft Teams and Zoom. All interviews were audio-recorded and transcribed verbatim. Data saturation guided the sample size; interviews were conducted until saturation was reached.

Psoriasis severity was self-reported by participants during interviews, as formal PASI scores or clinician assessments were not available. Participants were asked to describe their perceived severity, body surface area affected, and were asked about any PASI scores provided by their healthcare providers, to ascertain severity scores based on mild, moderate and severe [19].

3.3.3 Data Analysis

Data was analysed using a reflexive thematic approach based on the work of Braun and Clarke [20]. The analysis process began with familiarisation with the data. The researchers PH and SM familiarised themselves with the data through immersion in the audio files and transcripts of the individual interviews of each participant. PH (female) is a PhD student and registered nutritionist, with experience in conducting qualitative research and

thematic analysis. Subsequently, PH and SM independently coded the data using NVivo software. The codes reflected each researcher's own interpretations of patterns and meaning throughout the dataset. PH and SM then independently generated themes for the dataset through organisation of their independent codes. All themes were then discussed together with the wider research team (all authors of this paper) to explore the interpretations of the data using a collaborative and reflexive approach. Through these discussions, four key themes were generated, which were divided into subthemes.

3.4 RESULTS

3.4.1 Participants

17 individuals expressed interest in taking part, with 10 consenting to participate in the interviews. One participant dropped out prior to interview with no disclosed reason. Data saturation was achieved during these interviews, meaning that data replication was observed, and no new themes or insights were generated from the interviews [21], and no further recruitment was deemed necessary. Overall, 9 participants took part in the study (2 males, 7 females). The demographic information of the participants is summarised in **Table 1**.

Table 1. Demographics and characteristics of study participants (n=9)

Variable	N
Sex	
Female	7
Male	2
Age, years: mean (range)	39 (25 – 53)
Psoriasis duration, years: mean (range)	17 (2 – 34)
Ethnicity	
White British	9
Medication (current)	
Topical Steroids	5
Biologicals	3
Self-reported psoriasis severity	
Mild	2
Moderate	2
Severe	5

3.4.2 Generated Themes

Four key themes were generated from the collected data: (1) Impact of diet, (2) Dietary modification (3) Dietary information and (4) Dietary support. Each key theme contained multiple sub-themes, which are summarised in **Figure 1**.

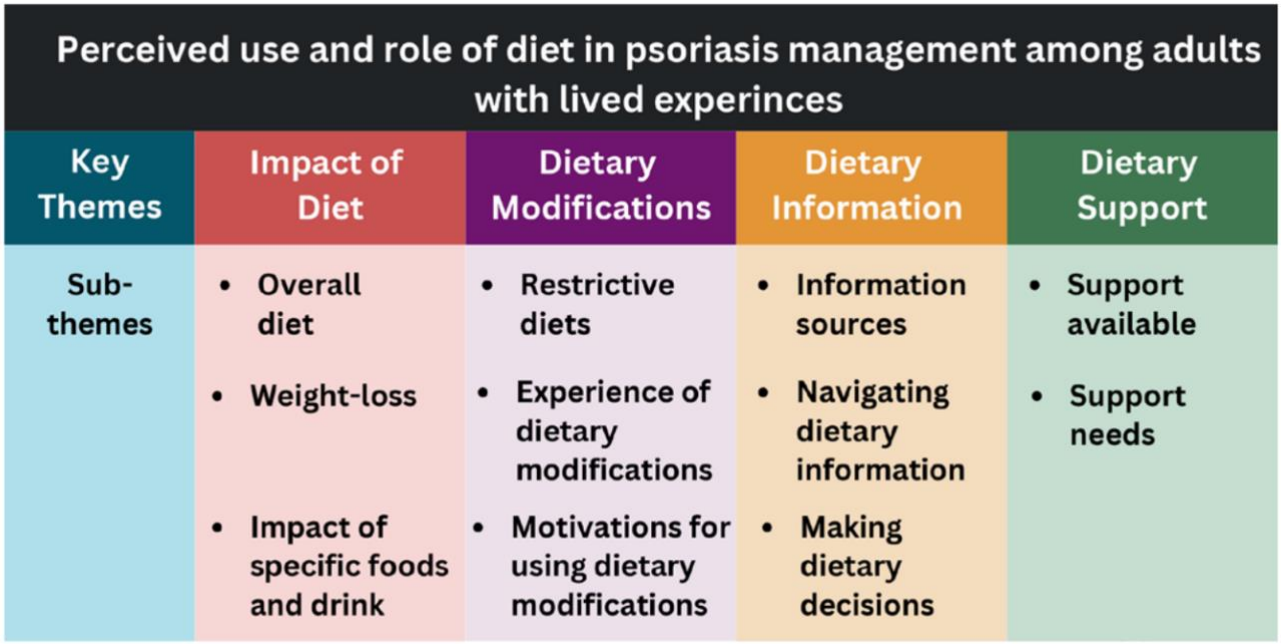

Figure 1. Key themes and sub-themes generated during interviews with UK adults living with psoriasis, regarding the use and experience of dietary modifications.

Key Theme 1: impact of diet

Participants discussed their thoughts on the role of diet in the management of psoriasis. They described the dietary factors that worsened or improved their psoriasis. A negative difference in psoriasis symptoms was more often experienced by participants than a positive difference to psoriasis symptoms through diet. Participants commonly described negative differences as a "flare" or "flare-up" which is an episode of worsened psoriasis symptoms. Additionally, participants also discussed increased itch, redness, and drier skin when describing the negative differences that they experienced.

Subtheme: overall diet

All participants (n=9) believed that diet could play a role in the management of psoriasis, and most (n=8) reported that diet had impacted their psoriasis in some way. The majority (n=7) stated they notice a negative difference in their psoriasis when they do not eat a healthy, balanced diet.

> *"....when I eat worse, it is worse. And when I eat healthy, it does get slightly better. [Recently] I haven't been eating very well and it is getting a lot worse than it used to be..."* (Participant 4)

> *"I know that when I'm eating healthier, it is... it doesn't clear up, but it does fade and it is better."* (Participant 9)

> *"I don't need the Methotrexate anymore and I put so much down to not needing it because I've got a much better diet than I ever had." (Participant 2)*

Subtheme: weight-loss

Regarding weight-loss, one of the few evidence-based dietary recommendations for psoriasis, those whose weight had fluctuated in their adult life (n=4), reported mixed impact of weight-loss or gain on their psoriasis.

> *"...if I'm eating worse, I'm putting weight on - which then is making it worse." (Participant 4)*

> *"I haven't sort of, noticed that it's [losing weight] made any difference, positive or negative on the psoriasis." (Participant 6)*

Subtheme: impact of specific foods and drink

The majority (n=7) stated they notice a negative difference in their psoriasis when they eat certain "trigger" foods. The most reported "trigger" foods and drink for psoriasis were alcohol, dairy, and sugar. Participants also reported that not eating enough fruit and vegetables had a negative impact on their psoriasis.

> *"I guess the things we eat as well, do have an impact because there are times when I do eat some things and I seem to be more itchy with other things that don't make me itchy."* (Participant 8)

"I don't eat anything that I know triggers [my psoriasis]." (Participant 3)

"Dairy and alcohol are the big offenders [for making my psoriasis worse]*."* (Participant 5)

"...if I have a lot of alcohol, that's really bad. It takes... it's not immediate - not like the next day but within the week. I know my... my face is a lot drier... it's a lot redder." (Participant 9)

"I've noticed that red wine will have a massive flare with me." (Participant 2)

"...not eating enough fruit and vegetables... eating too much sugar [are dietary triggers for my psoriasis]*."* (Participant 4)

Key Theme 2: dietary modifications

Dietary modifications involved intentional changes in the food and drinks consumed. Dietary modifications were commonly discussed by participants alongside the impact these had on their psoriasis symptoms. Almost all of the dietary modifications were restrictive. Only one participant had tried adding supplements, but found they had no impact on their psoriasis.

"primrose oil was one thing that was suggested and cod liver oil. So, I did start taking both of those, um... but they didn't have an effect." (Participant 9)

Subtheme: restrictive diets

Most participants (n=7) had tried following at least one restrictive diet to try and help their psoriasis symptoms. A restrictive diet refers to an eating pattern that reduces or cuts-out certain foods, food groups or energy intake. The most common restrictive diets tried by participants were reducing or removing dairy, cutting out nightshades and following gluten free diets. Nightshades are plants from the Solanaceae family, which include potatoes, tomatoes, peppers and aubergines (173). Dietary "cleanses" were mentioned and involved numerous different restrictions. The "cleanses" that participants attempted in this study were typically highly restrictive, involving either the consumption of only specific types of

foods or juice-based diets, where participants drank only juice and water for a set number of days.

> *"I've not had any dairy at all... [for 3 months]" and "[I tried going] completely gluten free for three months"* (Participant 1)
>
> *"[I am] actively avoiding nightshades"* (Participant 2)
>
> *"I've done lots of cleansing diets..."* (Participant 5)
>
> *"[I tried a diet] where you had to eat [...] just apples for like 2 weeks. And that was supposed to be some, like sort of... cleanse."* (Participant 6)

Participants reported mixed results from restricting dairy, 2 of the 4 participants that had tried reducing or removing dairy reported no difference to symptoms and 2 reported an alleviation of psoriasis symptoms. Weight-loss was also reported as a consequence of following a dairy-free diet.

> *"I found that cutting out milk made a bit of a [positive] impact" (Participant 9)*
>
> *"I have noticed that I've lost weight during the dairy-free diet because obviously... you can't eat so many things".* (Participant 1)

Following a GFD and avoiding nightshades was frequently reported to have no impact on psoriasis symptoms by those that had tried these, and following overly restrictive low-fat diets were believed to have worsened one participants' psoriasis.

> *"I did follow it for quite a while and was having like, gluten-free bread and other things ....] I didn't see a difference."* (Participant 9)
>
> *"Tried a gluten free diet for three months. And it made absolutely no difference whatsoever. And when I went back to eating copious amounts of gluten again, I didn't notice it got worse either." (Participant 1)*
>
> *"[I tried] nightshades... trying to avoid them. Um, and... but I didn't find that it worked"* (Participant 6)

"When I was restricted and going down the complete healthy route of eating like, healthy as in eating disordered healthy - it would be low-fat this, low-fat that. Like completely skinny milk - and that's when my skin was the worst." (Participant 2)

Subtheme: experience of dietary modifications

Those that had tried following a specific dietary modification to help their psoriasis, frequently reported that it was difficult to adhere to (n=6). Preparing separate meals was a barrier for those who cooked for others, and cutting-out foods or whole food groups meant that it was difficult to know what to replace them with. Restrictive diets also reported to provide little enjoyment and limited reward. Participants often reported that the restrictive diets had not made any or much difference to their psoriasis symptoms which was demotivating, or they had not been able to keep following them due to some requiring extremely strict exclusions.

"I just think I don't want to make myself miserable either. And to take over my life to that extent, either without really thinking that that would work. And there's a huge commitment, especially when you then cook for a family of five too… I don't want to take it out of their diets, so it will be quite difficult to do." (Participant 1)

"I'm quite happy to kind of - give up things and try new things. And I'm… but yeah, I find I find it really hard to kind of… because when you've got kids and you're like, doing different meals and different… all the different things, so it is difficult to sustain. That's… that's the thing. I think I'm happy to do it for a week or two but then life gets in the way" (Participant 9)

"…I had a lot of dairy. So, it's a lot to cut out." (Participant 1)

Subtheme: motivations for using dietary modifications

The main reason that participants reported wanting to try dietary modifications for their psoriasis were: 1) wanting a natural way to help manage the condition (n=4), 2) as a potential way to avoid starting or going back on medication that was perceived to be strong or associated with undesirable side effects (e.g., immunosuppressants) (n=4), and 3)

having autonomy and a sense of empowerment by being able to do something to help themselves, rather than being completely reliant on referrals to healthcare professionals and dermatologists (n=5).

> *"I've* [always] *looked for the more natural ways to control it."* (Participant 5)
>
> *"I'm so reluctant to go on something as strong as Methotrexate I have tried a gluten free diet for three months."* (Participant 1)
>
> *"I'm always looking for ways in which I myself can help the condition without always being referred … If there's anything… natural ways that it can be better, then I'm always up for doing it that way."* (Participant 8)

Key Theme 3: dietary information

Participants discussed where they obtained dietary information from, their experiences of navigating dietary recommendations from different sources, and gave insights into the factors that influenced their decisions to make certain dietary modifications.

Subtheme: information sources

The participants frequently reported that online patient forums and groups, as well as social media and Google were their main source of dietary information for psoriasis (n=8). This was primarily due to a lack of information from trusted sources such as healthcare professionals and organisations, and a lack of evidence-based information readily available to them. The dietary modifications recommended online and in the patient forums and social media groups were often restrictive. The restrictive dietary modifications often recommend eliminating certain food groups, or specific foods and drinks from the diet, and often had strict rules on what can and can't be eaten.

"...every diet you could possibly suggest. No nightshades, no gluten, no meat, no red meat, no sugar, no dairy and no alcohol, and pretty much any combination of those" [diets suggested on forums and trialled by forum members]. (Participant 1)

"If you listen to this doctor [an American doctor found online], *I might as well just not eat because he's going, "Nightshades, milk, cheese..." and I'm thinking, "Well, what can I eat?" "Chicken." That was all what he was saying. And I thought, "No." I couldn't live like that. I couldn't live with cutting all of them things out."* (Participant 7)

However, participants also frequently reported that the online psoriasis forums were useful for general support, even if the dietary information was perceived by some to be misleading or unfounded. They reported that the groups gave them a chance to feel understood, a place to ask questions about psoriasis without judgment and hearing coping strategies other PLwP had used. Overall, the online groups were perceived in a positive light and provided participants with psychosocial support.

"....it's good to be around... or have access to people who have gone through the same kind of things." (Participant 6)

"I find it helpful to know that there's other people that are going through similar things to what I've done in the past [....] but there's a lot of mis-led information out there as well." (Participant 2)

Subtheme: navigating dietary information

Participants often reported that when looking for dietary advice they felt overwhelmed by the amount of information available (n=7). The information was often contradictory and went against their better judgment. This caused uncertainty, and added to the cognitive burden of participants, alongside resulting in them trialling diets even when they were sceptical about the reliability and health impacts of the dietary changes recommended.

"... there are too many websites and too many pages with too many different conflicting things on and I get mind boggled [.....] one will say, don't eat that and then one will say, do eat that." (Participant 7)

"...as soon as you put in Google [diet and psoriasis] all this information comes out and...You'll try anything." (Participant 7)

"You're not meant to remove whole food groups... [...] So, I kind of question whether that is a good move." (Participant 1)

Subtheme: making dietary decisions

Participants reported that their decisions to try certain dietary modifications were influenced by before and after photos posted online by forum members who had changed their diets, anecdotal experience of dietary changes of other PLwP and popular wellness figures, even when they were sceptical (n=6). Participants reported trying dietary changes just to see if it would work for them, like it had for other people they had seen online.

"[Those who] post pictures of before and after, who'd done the Hannah Sillitoe diet. And that is, I think, probably what made me do this dairy-free diet and if I'm honest, that is probably from seeing the difference in her skin on the pictures. I don't know her... I've never had a conversation with her, but just thinking... if, if that is real, then I'd be silly to keep my mind closed to that as well. So, I'm willing to try it. Um, so... so it does influence me even if I take it with a pinch of salt." (Participant 1)

"I've been following, you know, Hannah Sillitoe who cleared her psoriasis by having a very vegan healthy lifestyle? And it's one of the reasons why I've become a vegan." (Participant 9)

Key Theme 4: Dietary Support

Participants discussed their experiences of the dietary support they had sought and received.

Subtheme: support available

All participants (n=9) perceived there to be a lack of dietary support available to them and that HCPs were reluctant to discuss diet during appointments. Participants recognised that this may be due to a lack of evidence of a relationship between diet and psoriasis. However, the lack of discussion about anything to do with diet was deemed unhelpful and left participants feeling frustrated. Additionally, if dietary advice was given by HCPs, it was reported to be vague healthy diet or weight-loss suggestions, without any specific information or support. This was perceived to be unhelpful and presumed dietary knowledge.

> *"[The Doctor] just kept on saying, "Oh, there's no cure. There's nothing that you can do."* (Participant 9)
>
> [when trying to discuss diet with HCPS] *"they're a little bit nervous. Um, I don't think they ever like to comment [..] they're very much like, um, "Just keep it varied."* (Participant 2)
>
> *"I think that expecting people to have like, a good knowledge of food, and what things can be replaced with, is... it's just quite unfair."* (Participant 3)
>
> *" ...dermatology and rheumatology, have both told me to, sort of lose weight and that'll help with the psoriasis and the psoriatic arthritis. But, um that's it... and I haven't noticed any improvement."* (Participant 6)

Subtheme: dietary support needs

Most participants (n=8) stated that they would benefit from dietary support from a healthcare professional with nutritional expertise, to help them to navigate the overwhelming amount of often contradictory dietary advice available, and the cognitive burden of trying to decide what was safe. Participants stressed the importance of evidence-based advice. Recognising that although there was limited evidence on the

relationship between diet and psoriasis, they were still willing to try diets suggested online, by friends and family or from popular wellness figures in case they did work for them. As a result, they wanted support to be able to try these diets safely and better understand the potential health implications, particularly for elimination diets.

> *"Just knowing what is safe, what will be a good move, where I can start…."* Participant 8)
>
> *"….. I didn't know how to do it properly. Like I don't know what gluten's in […] it's everywhere, isn't it?"* (Participant 2)
>
> *"Because such huge amounts of your food groups you're cutting out, I think I'd want to know that I was not depriving myself."* (Participant 1)
>
> *"…when someone's expecting you to cut something… that might make up quite a big part of your diet, then you need to know what you can be using instead."* (Participant 3)

There was no observed difference in perception or experience across any demographic characteristics. However, the sample size was too small to conduct any comparative analysis, and the sample size may also be the reason that no differences were observed.

3.5 DISCUSSION

Despite a growing interest in the role of diet in psoriasis management, there has been limited research exploring the perceptions of PLwP on the use and role of diet. To the best of our knowledge this is the first study to explore this topic in PLwP in the UK. The findings of this study have identified the challenges PLwP face and have highlighted potential gaps in support for PLwP regarding diet, alongside areas for further research to improve psoriasis care.

Most participants in this study perceived that diet had an impact on their psoriasis and took proactive measures to avoid foods known to trigger psoriasis flare-ups or worsen

symptoms. The most common dietary triggers perceived to negatively affect psoriasis in this study were alcohol, dairy, and sugar. This mirrors findings from previous studies [14]. Additionally, participants also perceived that eating a “generally healthy diet” characterised by consuming plenty of fruit and vegetables had a positive impact on their psoriasis. Previous studies have found that fruit and vegetable consumption was reported to alleviate symptoms by PLwP [22], and that higher fruit and vegetable intake was associated with lower psoriasis severity [23,24].

Specific diets were also commonly trialled by participants to try and help manage their psoriasis, all of which were restrictive. The most trialled diets were dairy restriction, gluten free, avoiding nightshades and a range of different cleanses, with limited or no perceived impact on psoriasis symptoms.

Dairy restriction was reported as a dietary modification trialled by 4 of the participants in this study, with mixed results. Previous research has reported that dairy elimination or restriction is common in PLwP in the US and provided alleviation of psoriasis symptoms in almost 50% of people that removed it [14]. However, there is limited research investigating the impact of dairy consumption on psoriasis severity. The reasoning behind eliminating dairy may be attributed to concerns about the pro-inflammatory effect of saturated fat, which is high in certain dairy products [25]. However, research indicates that dairy may have neutral to favourable effects on inflammation [25]. Furthermore, low-fat fermented dairy products such as yogurt have been shown to have anti-inflammatory effects attributed to the presence of probiotics [25,26]. Dairy products are also key sources of high-quality protein and essential micronutrients, including vitamin B12, calcium, magnesium, and zinc [27]. Eliminating or restricting dairy may negatively impact the intake of essential nutrients [28]. There is an absence of research on the type of dairy product perceived to have a negative impact on psoriasis symptoms, and this warrants further investigation. Additionally, one of the participants who reported removing diary, also reported losing weight whilst following a dairy-free diet. Weight-loss in PLwP who are also living with obesity or overweight has been shown to improve psoriasis symptoms [12].

Avoiding nightshades was a common dietary modification reported by participants. Nightshades are a family of plants that include potatoes, tomatoes, peppers, and

aubergines, they contain solanine and alkaloids which have been linked to inflammation in mouse models [14,29]. However, no human studies support this association; furthermore, nightshades are high in fibre and a rich source of antioxidants. Additionally, participants in this study and others have reported that eating fruit and vegetables improved psoriasis symptoms [23,24].

Gluten-free diets were also commonly trialled by PLwP, and research suggests that it could alleviate psoriasis symptoms, but only in PLwP who have coeliac disease or a sensitivity to gluten, otherwise, it is not recommended [12]. Previous research has also indicated that PLwP trial a GFD with mixed effects [14]. It is unclear whether PLwP recognise that the evidence only suggests following a GFD for those PLwP who are coeliac or have a diagnosed gluten sensitivity. Psoriasis is associated with numerous other autoimmune diseases, including coeliac disease [30]. However, greater awareness may be needed regarding who this type of diet is appropriate for, as gluten-free diets have been shown to be low in dietary fibre [31]. Greater dietary fibre intake is associated with a lower risk of cardiovascular disease and coronary heart disease, as well as lower systemic inflammation [32,33]. Dietary fibre also has appetite regulating and anti-obesogenic properties [32]. This is relevant to PLwP considering the associated comorbidities.

The combination of the prebiotic properties of dietary fibre consumption, alongside the probiotics found in fermented dairy products, may exert a moderating influence on the pathogenesis of psoriasis [34], by promoting gut health and subsequently regulating the innate and adaptive immune responses [34]. Therefore, the health benefits of these commonly eliminated foods are important considerations, as well as understanding the substitutions that may be consumed in place of the eliminated foods. Most participants felt overwhelmed with the number of dietary recommendations available online and did not feel as though they had the knowledge to be able to navigate them safely. This led to people trying restrictive diets, often against their better judgement and without the knowledge of how to do so safely. Following restrictive diets without the guidance of a HCP, can lead to micronutrient deficiencies [15] and studies show that individuals who follow restrictive diets, report significantly lower QoL and negatively impact mental wellbeing [35]. The restrictive dietary practices that PLwP adopt could therefore have detrimental

impacts on both physical and mental health. To build on the findings of this study, future research should further investigate the diets commonly trialled by PLwP to better understand the potential impacts of these on both physical and mental health.

This study found that there was a perceived lack of dietary support available for PLwP from HCPs. Despite recognising the shortage of evidence-based information on diet and psoriasis, participants often felt that HCPs were reluctant to discuss diet at all, and if dietary information was given it was perceived to be vague and lacking useful instruction. This led to individuals seeking dietary advice from alternative sources, primarily wellness figures and other PLwP on online forums or social media. The main motivations for participants wanting to trial dietary modifications was to find a natural way to help manage the condition, avoid medication side effects, and wanting autonomy over their condition. These findings echo previous studies which found that PLwP mainly use complimentary or alternatives to conventional medication due to treatment failures or unwanted side effects [36]. Previous research has highlighted the amount of dietary misinformation on social media [37]. Which further highlights the importance of providing dietary support to this group.

Moreover, a recent study exploring dermatology professionals' experiences of dietary habits of outpatients (n=159) found that psoriasis patients were one of the patient groups reported to ask about nutrition most often [38]. However, 73.1% of dermatologists did not feel confident in answering these questions and over 90% felt that additional nutrition training and access to specialist dietician support would be of benefit to dermatology practice [38]. This suggests that not only is there a high demand for dietary support patients, but that HCPs may require further training and resources to be able to provide this type of support. Considering patients' values and preferences alongside their physical, social and emotional needs is a core part of patient-centred care [39]. All of which further highlights the need for research in this area. Furthermore, many of the psoriasis associated co-morbidities are widely recognised to be related to diet [33,40]. As a result, engaging in discussions about dietary considerations with HCPs with nutritional expertise, or having access to evidence-based dietary support, could improve comprehensive care for PLwP.

Whilst also lessening the reliance on unsubstantiated online sources for dietary information.

3.6 LIMITATIONS

The small sample size of this study, that comprised of all white British and predominantly female participants means that further research is required to establish whether these findings are generalisable to PLwP across the UK. Furthermore, participants were recruited via an online psoriasis support group, which could have influenced the answers given by participants regarding sources of dietary information. The topic of the study may have led to a sample that perceived there to be a role for diet in managing psoriasis. Additionally, all dietary information and impact on psoriasis was self-reported. However, this was an initial exploratory study into a previously unexplored population and despite the limitations of this study, the findings provide novel and in-depth insight into the experience of PLwP regarding diet and potential support gaps in psoriasis care, which has the potential to inform subsequent larger research studies.

3.7 CONCLUSION

People living with psoriasis feel overwhelmed with the number of dietary recommendations claiming to help psoriasis and require more support to be able to navigate them. From the patient perspective, current dietary support provided by HCPs is lacking. As a result, PLwP turn to unregulated online platforms. This could have detrimental implications on the health and well-being of PLwP and therefore HCPs need to be able to confidently discuss diet and provide basic dietary support to PLwP until evidence-based dietary guidance for psoriasis is available. Understanding dietary support needs in psoriasis care from a HCP perspective warrants further investigation. The findings of this exploratory qualitative study will inform larger quantitative investigations of dietary practices of PLwP in the UK. This will enable better understanding of the use of diet, dietary support needs and opportunities to provide tailored support.

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CHAPTER 4 DIET AND PSORIASIS MANAGEMENT: A UK CROSS-SECTIONAL STUDY EXPLORING THE SELF-REPORTED DIETARY MODIFICATIONS, EXPERIENCES, AND SKIN RESPONSES OF PEOPLE LIVING WITH PSORIASIS

CHAPTER SUMMARY

In this chapter, I present a cross-sectional questionnaire that explores the perceptions, use and experiences of dietary modifications in the management of psoriasis among adults living with psoriasis in the UK. This questionnaire was conducted in response to, and informed by, the findings of the scoping review (Chapter 2) and the qualitative exploration of the experiences of PLwP regarding diet and psoriasis (Chapter 3). It is hypothesised that PLwP in the UK trial restrictive and non-evidence based dietary modifications to try and manage their psoriasis, and that their perceived skin responses to dietary modifications may vary. The type of dietary modification trialled may be associated with different demographic factors. Additionally, regarding dietary information, it is hypothesised that the majority obtain dietary information from unsubstantiated sources rather than from healthcare professionals and want more dietary support.

CONTRIBUTIONS

Poppy Hawkins: developed the questionnaire, collected and analysed the data, and drafted the manuscript. Rebecca Penzer-Hick, an experienced dermatology specialist nurse, reviewed the questionnaire to ensure accuracy and relevance to PLwP as well as a representative from PAPPA who also reviewed the questionnaire to ensure understanding. Athanasios Tektonidis provided support for the statistical analysis methodology used and contributed to the study design and drafting of the manuscript alongside Rosalind Fallaize and Kate Earl. All authors included reviewed and approved the final manuscript.

4.1 ABSTRACT

Background: There is limited evidence for the use of diet in psoriasis management. Research suggests that PLwP try unsubstantiated self-prescribed diets. Psoriasis affects approximately 2% of adults living in the UK. However, little is known about the perceptions, experiences and use of dietary modifications of PLwP in UK.

Objectives: To explore dietary modifications, skin responses, patient experiences, and dietary information acquisition among adults living with psoriasis in the UK.

Methods: A cross-sectional online questionnaire. Frequencies were used to report participant demographics and binary logistic regression to investigate associations between demographics, dietary use and perceptions. Qualitative insights were obtained on perceptions regarding dietary support.

Results: 271 UK adults living with psoriasis participated. 47.2% reported making a dietary modification to help their psoriasis, predominantly through restrictive changes. The most common restrictions were high-sugar foods (64.1%), dairy (63.3%), red-meat (53.1%) and gluten (49.2%). Common dietary additions were water (55.5%) vegetables (52.3%) and oily fish (43.8%). The impact of dietary modifications on psoriasis varied. Restricting alcohol had the highest reported positive impact on psoriasis. Those with coeliac disease or gluten sensitivity were more likely to report psoriasis improvement following a gluten-free diet compared to those without (OR 4.6; p=0.017). Participants with severe psoriasis (OR 2.268; p=0.027), aged 18-44 (OR 2.050; p=0.007), psoriatic arthritis (OR 2.754; p=0.003), or gluten sensitivity (OR 3.579; p=0.004) were more likely to have tried a dietary modification compared to those without these characteristics. The main dietary information sources were the NHS and online forums, HCPs were not used. Most participants (53.6%) wanted more dietary support.

Conclusion: This study is among the first to explore dietary practices of adults living with psoriasis in the UK. The findings suggest that dietary modifications are common, and impacts on psoriasis vary. There is a need and demand for enhanced dietary support, which should highlight the potential risks of common self-prescribed dietary modifications

adopted by PLwP, and promote healthy dietary practices. There is an opportunity for HCPs to enhance patient-centred care through discussions on diet. Future research should explore the HCP perspective and solutions for tailored dietary support for PLwP.

4.2 INTRODUCTION

There is high demand for evidence-based information on the dietary management of psoriasis among both people living with psoriasis (PLwP) and healthcare professionals (HCPs) involved in psoriasis care (1–4). The evidence base for the dietary management of psoriasis is limited to weight loss in those living with obesity or overweight (5,6) and a gluten free diet (GFD), in those with coeliac or gluten sensitivity (5,7). There are no specific dietary guidelines (8). Despite this, emerging evidence suggests that PLwP trial unsubstantiated self-prescribed dietary modifications beyond these (1,8,9). However, the utilisation and impacts of dietary modifications as well as the sources of information influencing these changes, remain unknown among PLwP in the UK.

People are increasingly relying on the internet and social media for nutrition-related information (10–12), which research has shown is often inaccurate and of low quality (13). A recent study on dietary information for psoriasis on Instagram found that most information was unsubstantiated and seldom produced by qualified HCPs (14). Following fad diets or nutrition-related misinformation can have detrimental impacts on health and quality of life, acting as a barrier to healthy eating behaviours (15–18). Furthermore, psoriasis is associated with cardiovascular disease (19), type 2 diabetes (20,21), metabolic syndrome (22,23), obesity (24) and depression (25,26). This underscores the importance of understanding the dietary practices of PLwP and the role this may play in overall health (27,28). The limited understanding of the use, perceptions and experiences of diet among UK adults living with psoriasis represents an important knowledge gap that limits the ability of HCPs to fully understand the support needs of PLwP, combat misinformation, and have meaningful discussions about diet with patients. Filling this gap would inform comprehensive patient-centred care, that may help in the management of psoriasis as well as overall long-term health. This is essential in the face of the associated conditions and plethora of dietary misinformation available.

The primary objectives of this questionnaire were: 1) to explore the attitudes and perceptions of PLwP concerning the role of diet in psoriasis management. 2) to ascertain common dietary modifications among PLwP and investigate their effects on psoriasis

improvement based on self-reported skin responses; and 3) to examine the sources of dietary information and experiences of dietary support among UK adults with psoriasis.

4.3 METHODS

A cross-sectional questionnaire was conducted to explore the perceptions, use and experiences of dietary modifications in the management of psoriasis among adults living with psoriasis in the UK. The findings are reported using the Strengthening the Reporting of Observational studies in Epidemiology (STROBE) for cross-sectional studies (30). The completed STROBE checklist can be found in appendix 1.

4.3.1 Questionnaire Development

The questionnaire was informed by a qualitative research study conducted with 9 UK adults living with psoriasis, which explored their experiences and use of diet (9) and a review of previous research (8). The language and scope of the questionnaire was reviewed by a specialist dermatology nurse and an individual living with psoriasis to ensure relevancy and understanding among the target population. Qualtrics software was used to create and host the questionnaire online.

4.3.2 Questionnaire Design and Participants

The questionnaire was in English and comprised 43 questions across 5 sections (**Figure 1**.). It contained a mix of closed questions, multiple-choice questions, Likert scales and short answer questions. The questionnaire used a branching logic function dependent on the answer provided by participants as to whether they had or had not tried a dietary modification to help manage their psoriasis (**Figure 1**). Participation was anonymous and participants were recruited via social media channels, and through the Psoriasis Association and Psoriasis and Psoriatic Arthritis Alliance (PAPAA) networks. The eligibility criteria for this study were aged ≥ 18 years, currently living in the UK, English speaking, and a diagnosis of psoriasis of any severity. The questionnaire was voluntary and upon completion, participants were offered the option to be entered into a randomised prize draw to win one of three £50 shopping vouchers. The voucher prize draw was not advertised to the participants before completing the survey. Data was collected between September 2022 and May 2023.

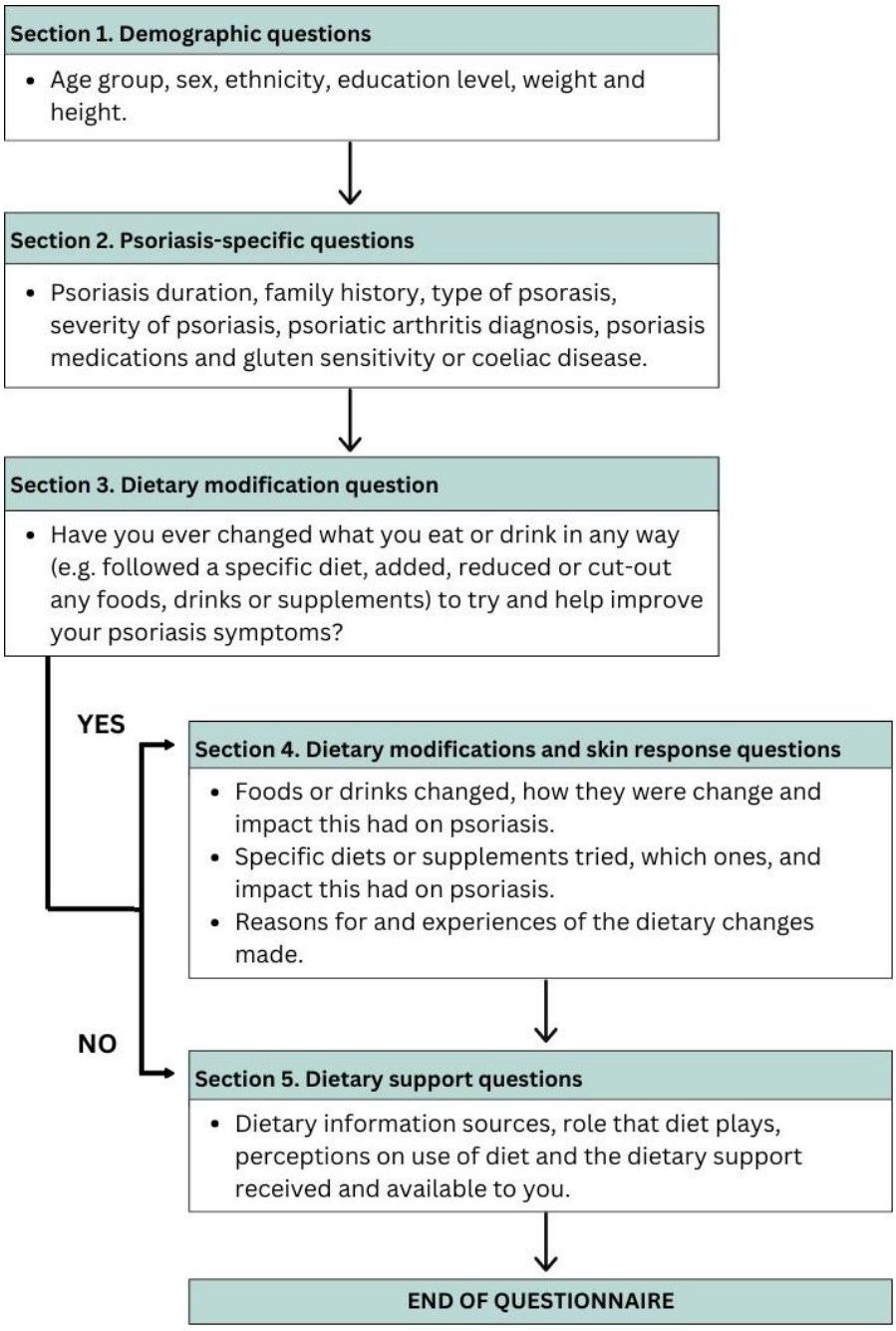

Figure 1. Questionnaire flow including brief overview of types of questions asked under each of the 5 sections and the branching logic used (overview of responses to questions are presented in the result section).

4.3.3 Data Analysis

Quantitative Analysis

Data were analysed using the statistical package for the social sciences (SPSS) software version 29. Demographic characteristics, perceptions, dietary modifications and reported

skin responses of participants were summarised using frequencies. Proportions for variables that contained missing values were expressed as valid percentages. Chi-square tests were used to test for association between demographic variables and perceptions, dietary changes, and reported psoriasis responses. The significance level was set at 0.05. The independent variables tested were; sex, age, BMI, education, psoriasis severity, presence of psoriatic arthritis, and presence of gluten sensitivity or coeliac disease. These variables were based on previous literature (1). Variables found to be statistically significant ($p < 0.05$) during chi-square tests were then analysed in binary logistic regression models.

Results are reported as an Odds Ratio (OR) with corresponding 95% confidence intervals (95% CI) and p-values, the significance level was set at 0.05. Power was calculated using Green's (1991) rule of thumb for regression analysis, which provides guidance on the minimum sample size required based on the number of predictors, with the formula $N \geq 50 + 8p$, where p is the number of predictors (31). Based on this method, a minimum sample size of 106 was required for the planned model. Age was collected as 9 individual groupings; the individual age groups showed no association with outcome variables. Age was thus grouped into two categories; 18-44 years and 45-75+ years for the analysis to increase sample size for each category, 18-44 years has been used as a standard young adult age group in previous health behaviour studies (32). Answers to Likert questions were grouped into nominal variables as follows: Improved ("fully cleared" and "improved") and did not improve ("no change" and "worsened"); Restricted ("cut-out" and "reduced") and Increased ("added" and "increased"). A missing value analysis (MVA) was conducted to assess missing data. For the outcome variables "would you like more dietary support?" and "Are you currently using diet to help manage your psoriasis?" missing data was identified to be missing at random (MAR), non-response to these outcome variables was associated with participants with severe psoriasis. Given the limitations associated with imputing values for categorical data in logistic regression (33,34), only outcome variables with complete responses were used for logistic regression analysis.

Qualitative Analysis of open-ended questions

Participants were asked to expand on the dietary support question in free text boxes. The responses were imported into NVivo software, coded and then analysed thematically.

Ethics

Ethical Approval was granted by The University of Hertfordshire, Heath, Science, Engineering & Technology Ethics Committee with Delegated Authority. Protocol number: aLMS/PGR/UH/05068(3).

4.4 RESULTS

4.4.1 Demographics

Overall, 271 UK adults living with psoriasis completed the questionnaire, with a 67.9% response rate. 71.2% of respondents were female and 92.6% were white. The sample represented all levels of psoriasis severity based on self-reported severity: 48.3% with mild psoriasis, 35.4% with moderate psoriasis, and 16.2% with severe psoriasis. Psoriatic Arthritis was reported in 19.9% of the population, and 11.8% reported either a gluten sensitivity or coeliac disease. Full participant demographics are presented in **Table 1**.

Table 1. Demographic characteristics of the participants that completed the questionnaire (n=271). Percentages may not total 100% due to rounding. IQR: interquartile range.

Demographic	**n**	**%**
Age group		
18-44 years	148	54.6
45-75+ years	123	45.4
Sex		
Female	193	71.2
Male	78	28.8
Ethnicity		
White	251	92.6
Asian	12	4.4
Other	8	2.9
Highest level of education		
University Degree	145	53.5
A-level or equivalent	80	29.5
GCSE or equivalent	46	17.0

BMI group kg/m2		
Underweight: BMI less than 18.5	11	4.1
Normal weight: BMI between 18.5 - 24.9	107	39.5
Overweight: BMI Between 25.0 - 29.9	84	30.9
Obese: BMI 30+	69	25.5
Self-reported Psoriasis Severity		
Mild	131	48.3
Moderate	96	35.4
Severe	44	16.2
Psoriasis duration, median (IQR)	18	20.0
Family history of psoriasis		
Yes	105	39.1
No	135	49.8
Don't know	30	11.0
Currently taking medication for psoriasis		
Yes	147	54.2
No	124	45.8
Presence of psoriatic arthritis		
Yes	54	19.9
No	217	80.1
Gluten sensitivity or coeliac disease		
Yes	32	11.8
No	239	88.2

4.4.2 Use and perceived role of diet in the management of psoriasis

Regarding use 47.2% of participants reported that they had tried changing their diet in some way to help manage their psoriasis, and 40.6% reported noticing that their diet affects their psoriasis. In total, 11.7% reported currently using diet alone and 20% alongside other treatments to manage their psoriasis (**Table 2**). However, only 15.8% reported discussing diet with a healthcare professional, yet 48.3% strongly or somewhat agreed that it was important to discuss diet and psoriasis with a HCP (**Table 2.**).

Table 2. Responses to questions regarding the use and perceptions of diet and psoriasis

Use and Perception	**n**	**%**
Have you ever changed your diet to try and help your psoriasis? (n=271)		
Yes	128	47.2

No	143	52.8
Have you ever noticed that what you eat or drink affects your psoriasis? (n=271)		
Yes	110	40.6
No	161	59.4
What role is diet currently playing in the management of your psoriasis (n=240)		
I am using diet alone to manage my psoriasis	28	11.7
I am using diet alongside treatments to manage my psoriasis	48	20.0
I am not using diet at all to help my psoriasis	164	68.3
Have you ever discussed diet and psoriasis with a healthcare professional? (n=240)		
Yes	38	15.8
No	202	84.2
"It is important to discuss diet and psoriasis with a HCP", to what extent do you agree with this statement (n=240)		
I strongly agree	51	18.8
I somewhat agree	80	29.5
I neither agree nor disagree	89	32.8
I somewhat disagree	16	5.9
I strongly disagree	4	1.5

4.4.3 Dietary Information sources and support

In the last 12 months, 55% of participants had searched for information on diet and psoriasis (**Table 3.**). Participants were asked to select all of their main information sources for diet and psoriasis, used over the last year. The NHS website and Online Forums were the most common sources of dietary information for PLwP with 50.7% and 43.2% of

participants reporting to have used them in the last year, respectively. Social media was rarely used, and no one reported using HCPs as a source of dietary information in the last 12 months (**Figure 2.**).

Table 3. Shows the number of participants that looked for information on diet and psoriasis in the last 12 months.

	n	%
In the last 12 months have you looked for information on diet and psoriasis? (n=240)		
Yes	132	55.0
No	108	45.0

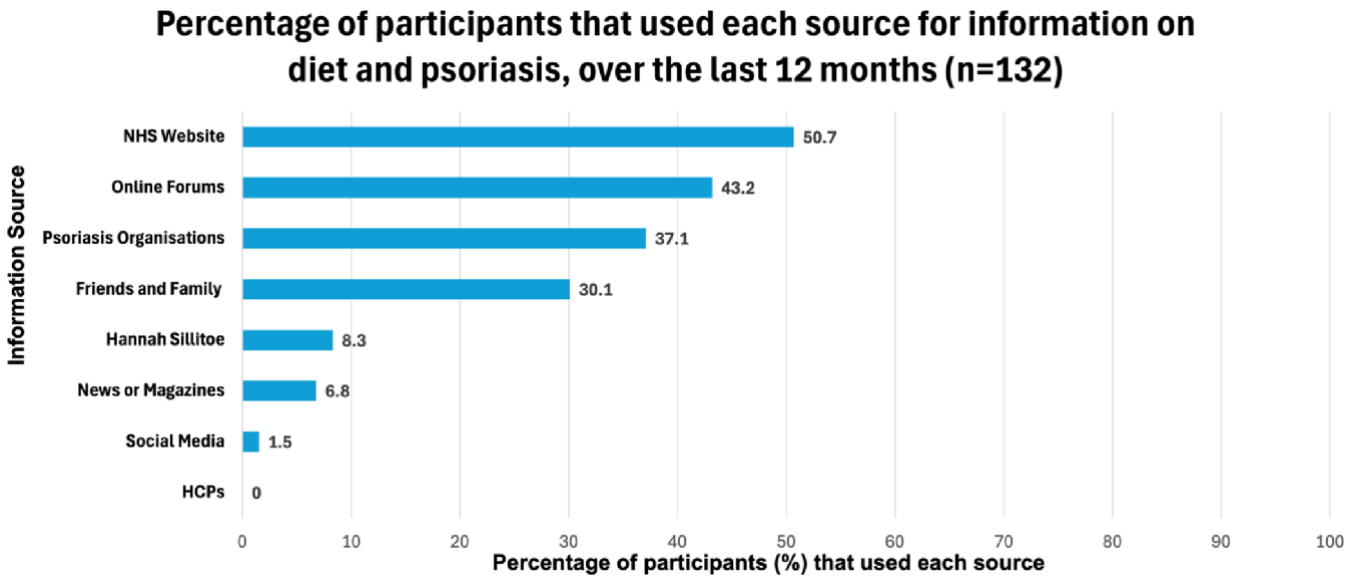

Figure 2. Shows the respondents main source for dietary information over the last 12 months. HCP; healthcare professionals.

4.4.4 Dietary modifications and reported skin responses

Participants who reported making a dietary modification to help their psoriasis (n=128) were asked to detail the specific changes made and the impact on their psoriasis. The term "restricted" refers to items reduced or cut-out, while "increased" refers to items added or increased. Regarding the reported impact on psoriasis symptoms, "improved" indicates participants who reported an improvement or complete clearance of psoriasis following

the dietary modifications. Overall, restrictive dietary changes were more common than dietary additions (**Table 4.**).

Table 4. Dietary modification type reported to have been tried to help psoriasis by the participants of this study. The term "restricted" refers to items reduced or cut-out, while "increased" refers to items added or increased. Most participants had tried multiple types of dietary modifications hence why the frequencies may be over 100%.

	n	%
Dietary additions or removals (n=128)		
Reported restricting a dietary component	121	94.5
Reported increasing a dietary component	112	87.5
Did not specify how diet was modified	5	3.9
Dietary Modification type made (n=128)		
Reported a trial of a specific diet for psoriasis	101	78.9
Reported modifying specific drinks (restricting or increasing)	108	84.8
Reported modifying specific foods (restricting or increasing)	125	97.7
Reported a trial of taking supplement for psoriasis	102	79.7

4.4.5 Specific diets and reported skin responses

Overall, 78.9% of participants that made a dietary modification reported following a specific diet to help manage their psoriasis (**Table 4.**). The most common diets tried were dairy-free (81/128, 63.3%) and vegetarian (40/128, 31.2%). The percentage of respondents reporting improvement of psoriasis following a dairy-free diet was 53.6%, while 43.5% reported no change and 2.9 % reported a worsening of symptoms. Of those who followed a vegetarian diet, 42.5% reported an improvement, 47.5% reported no change and 10% reported worsening of symptoms (**Figure 3.**).

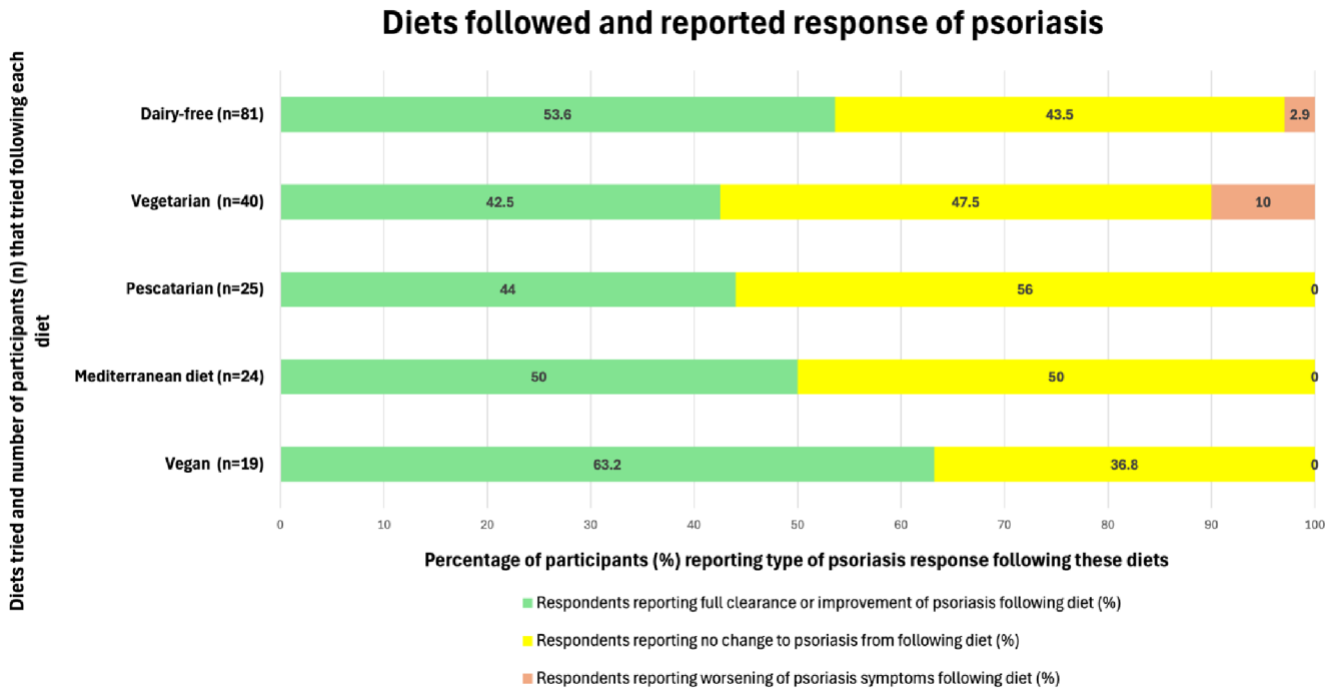

Figure 7. Shows the diets trialled by adults living with psoriasis in the UK and the reported psoriasis response to following each diet.

4.4.6 Specific food, drink and supplements

Specific food modifications were the most common type of dietary change made by participants, with (97.7%) reporting making one to try and help their psoriasis. The most frequent are described.

Dietary Restrictions

High-sugar foods (HSFs) were restricted by (82/128, 64.1%) of participants, with 52.4% of participants reporting that following this dietary modification improved their psoriasis symptoms. Red meat was restricted by (68/128, 53.1%) and was perceived by 29.4% of participants to improve their psoriasis, yet 51.5% found that it made no change. Further restrictions and psoriasis impacts are presented in **Figure 4.**

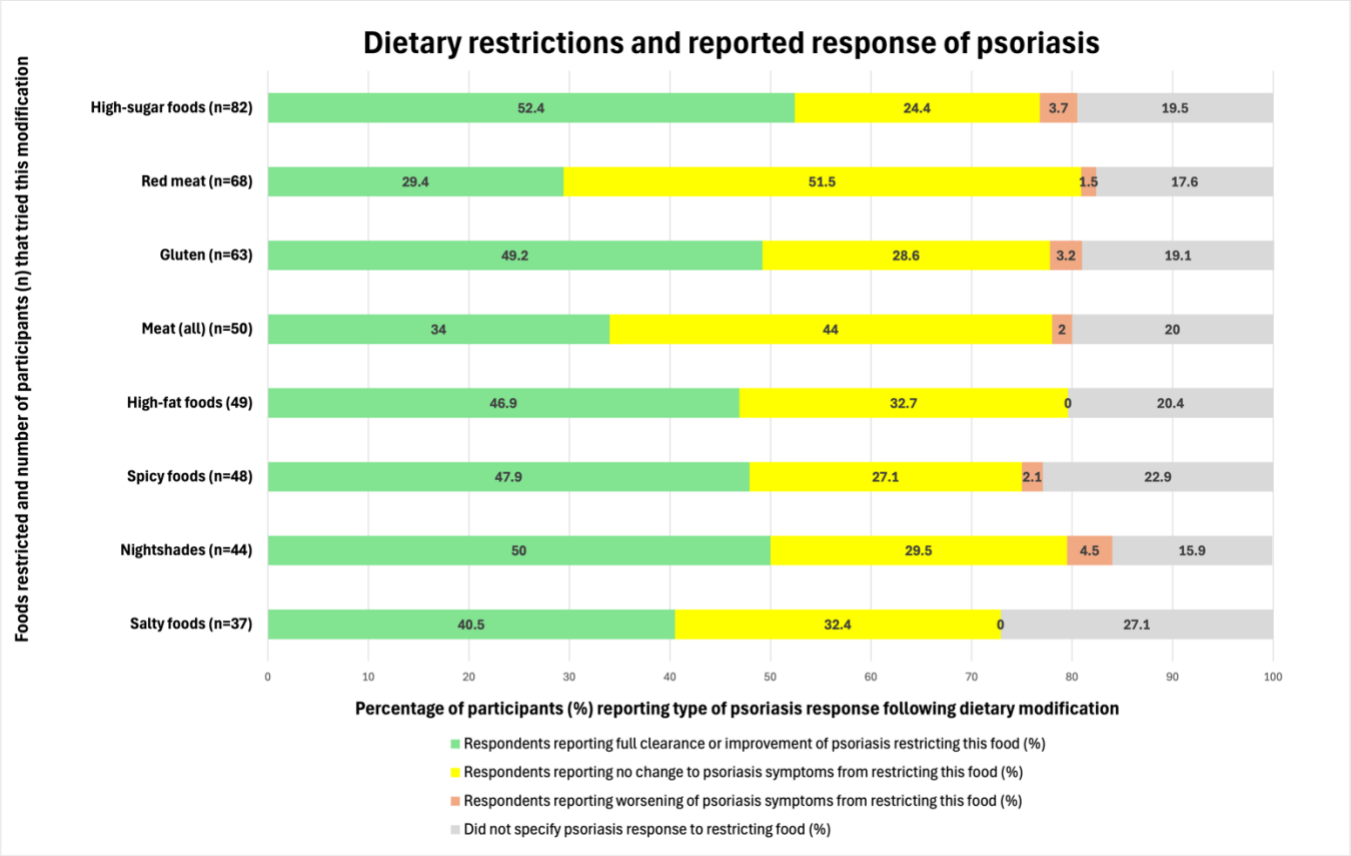

Figure 4. Shows the number of participants that tried restricting each food and the reported impact of this dietary modification.

Dietary Additions

Participants primarily reported increasing the consumption of vegetables (67/128, 52.3%) oily fish (56/128, 43.8%), and fruit (52/128, 40.6%) to try and help their psoriasis. The reported skin responses were mixed, with 44.8% of those that increased vegetables, 51.8% of those that increased oily fish and 46.2% of those that increased fruit reported that their psoriasis improved. However, approximately a third of participants did not notice any change to their psoriasis from increasing these foods in their diets (**Figure 5.**).

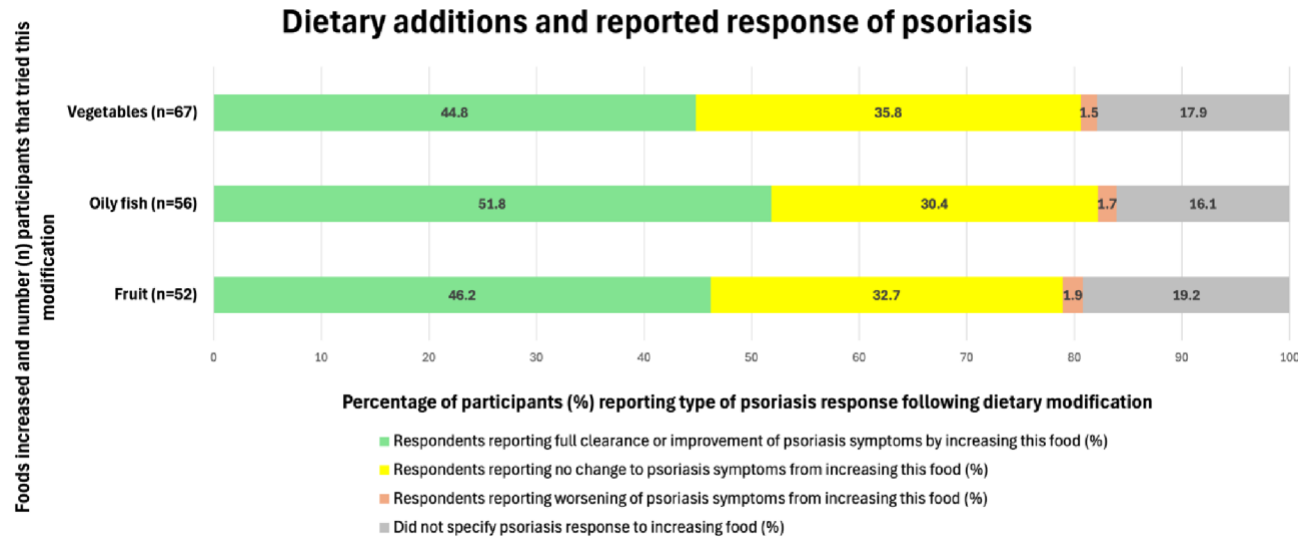

Figure 5. Shows the number of participants that tried increasing each food and the reported impact of this dietary modification.

Drink modifications

Alcohol was restricted by (59/128, 46.1%) of participants, with 69% of people who restricted alcohol reporting improvement of their psoriasis symptoms. Water intake was increased by (71/128, 55.5%) of participants, 56.3% of which reported improvement of their psoriasis symptoms following this change (**Figure 6.**).

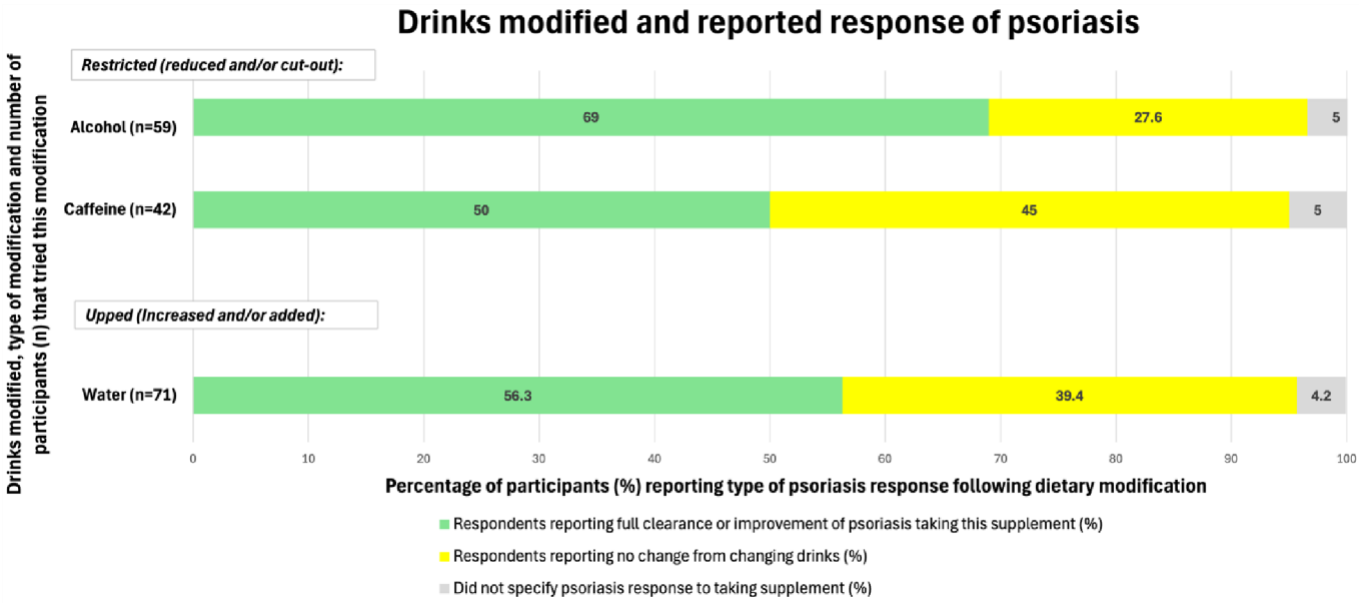

Figure 6. Shows the number of participants that tried modifying drinks in their diet, how they were modified and the reported impact of this modification on psoriasis skin symptoms.

Supplements

The most common supplements tried were vitamin D and omega-3, with (61/128, 47.7%) reporting taking vitamin D and (31/128, 24.2%) taking omega-3 to try and help their psoriasis. Most participants, 52.5% and 54.8% reported no change in psoriasis symptoms from taking Vitamin D and omega-3 respectively (**Figure 7.**).

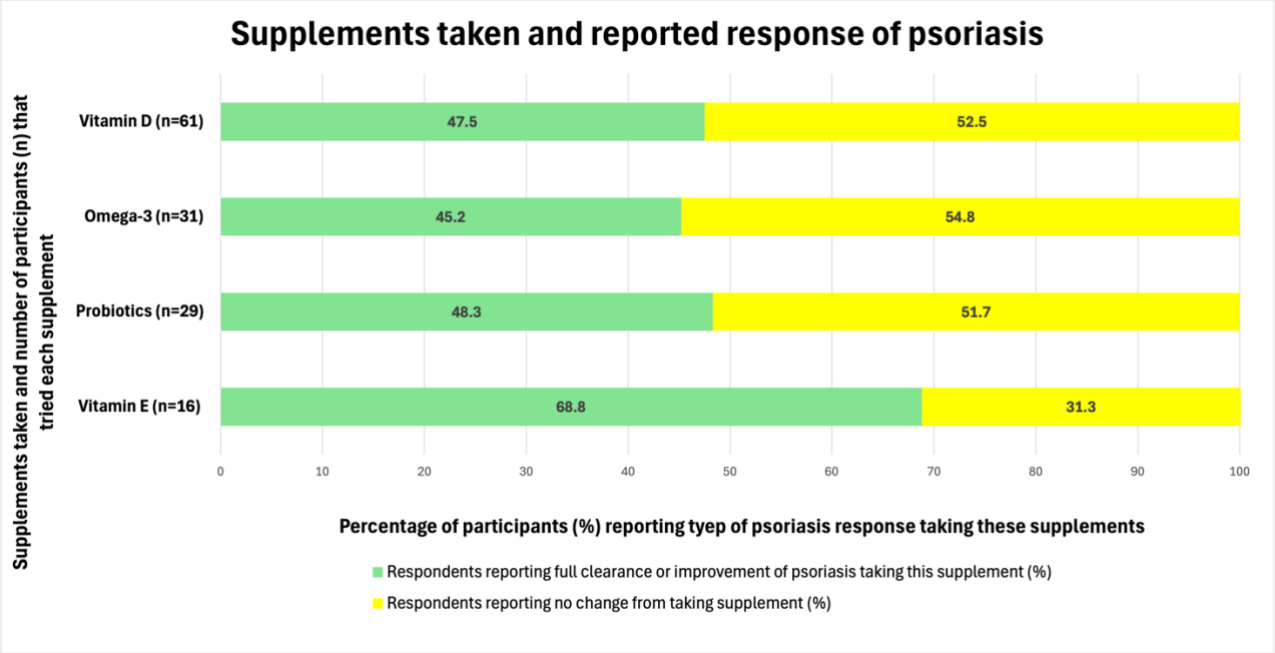

Figure 7. Shows the number of participants that tried taking specific supplements and the reported impact of this modification on psoriasis skin symptoms.

4.4.7 Demographic factors associated with perceptions, dietary practices and psoriasis reported response

Multivariate binary logistic regression was used to identify independent predictors of dietary practices and perceptions regarding diet and psoriasis. Independent predictors of making a dietary modifications for psoriasis were having psoriatic arthritis (OR =2.754, p=0.003), aged 18-44 years (OR =2.050, p= 0.007), having a gluten sensitivity or coeliac disease (OR 3.579, p=0.004) and having severe psoriasis (OR = 2.268, p = 0.027), compared to participants without these characteristics (**Table 5.**). Those with a gluten sensitivity or

coeliac disease were 4 times more likely to notice dietary impact on their psoriasis compared to those without (p<0.001) (**Table 6.**).

Table 5. Multivariate binary logistic regression model for diet changed to help psoriasis (yes /no) as the binary dependent variable, (Nagelkerke R^2=0.168).

Independent Variable	*OR*	*95% CI*	*P-value*
Psoriatic Arthritis	2.754	1.413 - 5.366	**0.003**
Aged 18-44 years	2.050	1.221 - 3.440	**0.007**
Gluten sensitivity or coeliac	3.579	1.495 - 8.568	**0.004**
Severe psoriasis	2.268	1.098 - 4.684	**0.027**

Table 6. Multivariate binary logistic regression model for noticing diet makes a difference to psoriasis (yes /no) as the binary dependent variable, (Nagelkerke R^2=0.112).

Independent Variable	*OR*	*95% CI*	*P-value*
Aged 18-44 years	1.872	1.115 - 3.145	**0.018**
Gluten sensitivity or coeliac	4.491	1.962 -10.281	**< 0.001**
Severe psoriasis	1.657	0.841 - 3.263	0.144

Regarding specific dietary changes made, those with severe psoriasis were 3 times more likely to try cutting-out dairy than those with mild or moderate psoriasis (p=0.002). Being in the younger age group and those with a gluten sensitivity or coeliac were also associated with making this dietary modification (**Table 7.**).

Table 7. Multivariate binary logistic regression model for types of dietary changes made, Dairy-free diet followed (Yes/No) as the binary dependent variable, (Nagelkerke R^2=0.136).

Independent Variable	*OR*	*95% CI*	*P-value*
Psoriatic Arthritis	1.734	0.899 - 3.346	0.101
Aged 18-44 years	1.921	1.089 - 3.391	**0.024**
Gluten sensitivity or coeliac	2.443	1.115 - 5.353	**0.026**
Severe psoriasis	3.019	1.518 - 6.005	**0.002**

Participants with gluten sensitivity or coeliac disease were 7 times more likely to have tried restricting gluten compared to those without these conditions (p<0.001) (**Table 8**.). Additionally, they were 4 times more likely to report a positive impact on their psoriasis from restricting gluten (p=0.017) (**Table 9.**). No associations between the impact of other dietary modifications and demographic variables were observed.

Table 8. Multivariate binary logistic regression model for types of dietary changes made, GFD followed (yes/no) as the binary dependent variable, (Nagelkerke R^2=0.145).

Independent Variable	*OR*	*95% CI*	*P-value*
Gluten sensitivity or coeliac	7.093	2.263 - 22.288	**<0.001**

Table 9. Multivariate binary logistic regression model for improved psoriasis following GFD restriction (yes/no) as the binary dependent variable, (Nagelkerke R^2=0.143).

Independent Variable	*OR*	*95% CI*	*P-value*
Gluten sensitivity or coeliac	4.632	1.319 -16.261	**0.017**

Table 10. Multivariate binary logistic regression model for types of dietary changes made, restricted high-sugar foods (yes/no) as the binary dependent variable, (Nagelkerke R^2=0.164).

Independent Variable	*OR*	*95% CI*	*P-value*
Psoriatic Arthritis	2.899	1.382- 5.574	**0.001**
Gluten sensitivity or coeliac	3.637	1.638 - 8.075	**0.002**
Severe psoriasis	2.755	1.382- 5.574	**0.004**

4.4.8 Motivations and experiences of the dietary modifications made

The main motivations for participants (n=100) to change their diet to help manage their psoriasis included the want to improve overall health (61.3%), the preference for a natural way to help their psoriasis (59.1%), and the ineffectiveness of other treatments (38.7%). Additionally, 21.5% were motivated by recommendations from friends and family, and 20.4% by recommendations on patient forums. Regarding their experiences, 52% found it difficult to adhere to the changes they implemented. The main challenges reported were a lack of support or guidance for following the dietary modification, (63.5%) the time commitment needed to adhere to it (55.8%), little impact on psoriasis seen, (50%), and that it was too expensive to maintain, 44.2%.

4.4.9 Dietary Support

The majority of participants (n=105; 53.6%) expressed a desire for more dietary support related to psoriasis (**Table 11**). Of these, 96.2% provided further details on the type of

support they would like through open text responses, selected quotes of which can be seen in **Table 12,** under each generated theme.

Table 11. Shows the number of participants that wanted more support on diet and psoriasis.

Would you like more support regarding diet and psoriasis? (n=196)	**n**	**%**
Yes	105	53.6
No	93	47.4

Table 12. Table of generated themes and a selection of quotes obtained from the open text boxes and thematic analysis, on perceptions regarding dietary support among PlwP.

Theme 1: Dietary Information Participants indicated that dietary guidance and up-to-date information from current research would be useful, regarding psoriasis.
"To be given advice and support regarding dietary changes" *"Information would be enough I am happy managing any changes"* *"Provision of evidence-based advice regarding dietary implications on psoriasis"* *"Up to date information from actual research"*
Theme 2: Dietary support from HCPs Participants frequently mentioned the importance of GPs, doctors, and dermatologists in being able to provide general dietary advice and information about the relationship between diet and psoriasis. They emphasised the importance of healthcare professionals being willing to discuss diet and psoriasis, rather than being dismissive of the idea.

"There seems to be no advice from dermatology or GPs regarding diet when discussing psoriasis" "It would be good if my GP made [dietary] information available" *"I'd like GPs/dermatologists to at least entertain the idea of a diet-led approach."* *"Just any level of interest would be nice"* *"I haven't ever found a doctor or consultant that took diet seriously..."*
Theme 3: Referrals to relevant professionals Additionally, some participants highlighted the value of referrals to specialists, such as nutritionists and dietitians, to further enhance dietary support.
"Dietitian referrals could help" *"Referral to a nutritionist"*

4.5 DISCUSSION

This exploratory cross-sectional questionnaire aimed to investigate the dietary practices, perceptions and experiences of UK adults living with psoriasis. Furthermore, it investigated the main sources of dietary information and perceptions on the dietary support available among this population.

Use and perceived role of diet in the management of psoriasis

The findings suggest that dietary modification is common among PLwP in the UK, with almost half of participants reporting changing their diet to try and help their psoriasis. Regarding current use of diet, 31.7% reported that they are currently using diet to help manage their psoriasis, either alone (11.7%) or alongside other treatments (20%). These findings are consistent with a previous national study conducted in the US, where the majority reported making dietary modifications and 36.3% of participants reported that

their psoriasis was completely or partially managed with diet (1), suggesting a substantial percentage of PLwP are turning to diet as part of their psoriasis management strategy. Furthermore, only a small number of participants report discussing dietary changes with HCPs. In this study, only 15.8% of respondents had discussed dietary changes with a HCP. This indicates that dietary changes made by PLwP are often self-prescribed, which could have negative health impacts (17,35).

The prevalence of self-prescribed dietary modifications among individuals with psoriasis may stem from the desire for information on diet coupled with a perceived lack of dietary support from HCPs. Over half of respondents expressed a desire for greater dietary support and many perceived that discussing diet with HCPs was important. The qualitative insights found that participants reported feeling dismissed by HCPs when they brought up diet. This may be the reason that participants turned to online forums for dietary advice, with no respondents reporting HCPs as a source of dietary information in the past year. While the limited evidence on diet and psoriasis (5,8) may impact the ability of HCPs to provide specific recommendations, the findings highlight a clear need for better communication and support regarding diet for PLwP. Moreover, improving general health was reported as the most common reason for participants deciding to change their diet to help manage their psoriasis. The importance of dietary guidance is further underscored by the associated health conditions (19,23,24) many of which have robust evidence to support diet as an important factor in their management (36–38). This indicates that by dismissing diet or not providing support, HCPs are missing out on a key opportunity to provide healthy eating support to a population that may benefit from this advice, and that have a desire for it. Developing dietary support for PLwP in the UK is therefore a necessity. Furthermore, understanding the perspective of HCPs on this matter would allow for a more comprehensive understanding of dietary support integration into psoriasis care.

Dietary modifications and reported skin outcomes

Dietary restrictions

Dairy, HSFs, gluten, red meat, and alcohol were the most commonly restricted dietary components. These have been previously reported as dietary “triggers”, a term used to describe a factor which causes a psoriasis flare-up or worsening of symptoms (1,8), and

are commonly restricted dietary components among PLwP (1). Restricting alcohol had the highest reported positive impact on psoriasis among restrictive modifications, and red meat the lowest. The reported impact of restricting dairy and HSFs were mixed, and reported improvement following gluten restriction was associated with gluten sensitivity or coeliac disease.

Studies suggest an association between alcohol intake and the development of psoriasis (39,40) as well as a correlation between psoriasis severity and increased alcohol consumption (41,42). The negative effect of alcohol on psoriasis is attributed to its promotion of keratinocyte proliferation and upregulation of pro-inflammatory cytokines (43), key contributors to psoriasis plaque formation (44,45). Ethanol and its metabolites (acetaldehyde and acetone) can be both initiating and exacerbating factors in the inflammatory processes of psoriasis (43). Reactive oxygen species (ROS) are generated in the skin in response to alcohol consumption and increase pro-inflammatory signalling cascades, leading to elevated levels of T-helper 17 (Th17) cells (43). In imiquimod-induced psoriasis mouse models, ethanol consumption resulted in increased epidermal thickening, interleukin (IL)-17 expression and Th17 cell recruitment to the skin (46). Alcohol consumption in mice has led to increased plasma tumour necrosis factor alpha (TNF-a) level (47). Both TNF-a and IL-17 play a key role in the inflammatory feedback loop of psoriasis (44,48). Regarding HSFs and psoriasis, evidence from mouse models suggests that simple sugars in the diet lead to dysbiosis of the intestinal microbiome which promotes harmful bacteria and increases inflammatory cytokine levels (49). Increased amounts of glucose specifically promoted Th17 differentiation through upregulation of mitochondrial ROS in T-cells (49). Additionally, the sugar content in the diet of mice has been shown to be a critical factor in psoriasiform inflammation (50). However, there are an absence of studies on HSFs and psoriasis in humans.

Regarding dairy, no studies have been conducted on its impact on psoriasis. The mechanistic links behind the reported trigger or beneficial impact of restricting dairy may be due to links to inflammation in dairy products high in saturated fat or the lactose content of certain dairy products (51). Some studies have suggested a potential inflammatory link between consumption of A1 β-casein in milk and increased faecal

calprotectin, a marker of intestinal inflammation (52,53). However, a recent systematic review found that dairy products and dairy proteins have neutral to beneficial effects on biomarkers of inflammation (51). There is a broad spectrum of dairy products with varying micro- and macronutrient profiles (51). This may explain the varied impact reported from dairy restriction in this study, as well as the foods used to replace it, if any. Furthermore, the type of dairy restricted and replacements may have varying impacts on health. Eliminating dairy without careful consideration of micronutrient intake could lead to micronutrient deficiencies (MND) (54–56). No information was collected on the specific dairy products these participants typically consumed and subsequently restricted, or the foods used to replaced dairy in this study. Research into this could improve mechanistic understanding of the impact of dairy on psoriasis, and provide insight into the potential health impacts of this common dietary restriction.

The finding that participants reporting a gluten sensitivity or coeliac disease were more likely to have tried restricting gluten is unsurprising. Notably, this group was also the only identified that were more likely to report an improvement in psoriasis following this dietary modification. Coeliac disease is more prevalent in people living with psoriasis (7,37), and eliminating gluten in those who are positive for gluten sensitivity or coeliac disease is one of the few evidence-based dietary recommendations for psoriasis (5).

Restricting red meat was also commonly tried, with the majority reporting no beneficial impact of this restriction. No studies have looked at red meat and psoriasis. In moderate amounts red meat can provide an important source of protein and various micronutrients including iron, zinc and B vitamins (57).

Following restrictive diets without the support of HCPs can result in micronutrient deficiencies and have negative impacts on well-being and relationships with food. Research has shown that systemic inflammation is seen in undernourished states, serum levels of IL-6 were significantly higher in undernourished patients compared with healthy controls (58). More research is required to fully elucidate the impact of undernutrition on inflammation. However, IL-6 is an inflammatory cytokine that is increased in PLwP (59). This underscores the need to provide dietary support to this population as the self-prescribed diets to help psoriasis may have counterproductive impacts.

Dietary Additions

Increasing oily fish intake was common, which was in line with previous studies (1). Oily fish contains long-chain omega-3 fatty acids which have been shown to have anti-inflammatory properties (60). Currently though omega-3 supplementation has shown to have mixed impacts on psoriasis in RCTs (5,61,62). Increasing fruits and vegetables also reportedly improved psoriasis symptoms. Fruits and vegetables are key sources of vitamins and polyphenolic compounds which have antioxidant and anti-inflammatory properties (63–65), and have also been shown to enhance immune pathways and inhibit certain pro-inflammatory pathways (63,66). Specifically relevant to psoriasis, they have been shown to reduce pro-inflammatory cytokines IL-6 and TNF-α (63,67,68) which are involved in the pathophysiology of psoriasis (44,69). Fruits and vegetables are also important sources of dietary fibre, and consuming adequate amounts of fibre and polyphenol-rich diets are associated with multiple health benefits, and reduced risk of certain psoriasis associated conditions (70–72). One observational study found that among PLwP, those with lower psoriasis severity had significantly higher intakes of vegetables (73), however, more research is needed.

Although only 16 participants reported taking a Vitamin E supplement, the majority reported perceived improvements in their psoriasis symptoms as a result (68.8%). Vitamin E has anti-inflammatory properties, and supplementation has been shown to reduce serum levels of CRP, TNF-a and IL-6 in humans, evidence also suggests that Vitamin E exerts immunomodulatory effects (65). Regular supplementation of Vitamin E has been shown to help reduce joint pain, stiffness and improve QoL in people living with rheumatoid arthritis (74). This has been attributed to its antioxidant and anti-inflammatory properties. Highlighting a potential area of further research.

Regarding the beneficial effect of water consumption on psoriasis. Disruptions in the skin barrier have been linked to increased trans-epidermal water loss (TEWL) in psoriasis (75). Increasing water consumption may positively impact skin physiology and reduce TEWL, though more research is needed, specifically on psoriasis, as the mechanisms remain unclear (76).

Demographic variables associated with perceptions and use of diet

The findings suggest that specific demographics were independent predictors of dietary changes among PLwP. Younger participants, those with severe psoriasis, psoriatic arthritis or gluten sensitivity or coeliac disease, were more likely to make a dietary change to help their psoriasis compared to those without these conditions. This may be due to health seeking behaviours prompted by the presence of multiple health conditions. Research indicates that people living with multiple chronic conditions have a high prevalence of complementary and alternative medicine (CAM) use, including diet (77,78).

Severe psoriasis is associated with increased risk of CVD compared to those with lower severity (19,79,80). Therefore, the finding that individuals with severe psoriasis are more likely to attempt dietary modifications is important. It suggests that they may be more willing to take on board heathy dietary advice, making dietary changes that could help manage the comorbidities. Highlighting a key opportunity for HCPs to provide healthy dietary advice. Furthermore, certain dietary modifications, such as cutting-out dairy which in this study participants with severe psoriasis were more likely to follow, could exacerbate comorbid conditions if not carefully implemented (81–84). This further highlights the need for tailored evidence-based guidance that provides PLwP in the UK with safe and effective dietary support. Future research should take into account the perspectives and input from key stakeholders in psoriasis care, and relevant experts to develop this type of resource, to ensure it is user-friendly and meets the dietary support need expressed in this study.

4.6 LIMITATIONS

This study had several limitations. Firstly, the participants were predominantly white, female with a higher education, which may limit the generalisability of the findings. The survey was primarily promoted online, even though an offline option was available, which may have excluded individuals without internet access. The study may have attracted participants more likely to have attempted dietary modifications, introducing a selection bias. The dietary modifications followed and their impacts on psoriasis were self-reported, which could have led to inaccuracies and bias. Furthermore, the study did not assess the nutritional composition of the diets followed or quantify the specific amounts of each

dietary component that were either restricted or increased for each participant, which may have contributed to the variability in reported skin responses among participants.

Furthermore, the term improved regarding psoriasis symptoms was broad, and understanding specific impacts of dietary modifications on psoriasis may have provided further insight. Two questions on support and use of diet had a non-response associated with severe psoriasis, this may suggest that further investigation is required into this population to understand support needs, especially considering they were shown to be more likely to make a dietary change. Despite this, this study provides novel and valuable insights into the experience of UK adults living with psoriasis.

4.7 CONCLUSION

This study is among the first to explore the use, experiences, and perceptions of diet in managing psoriasis within a UK population. The findings highlight that PLwP make dietary changes with good intentions, to try and help their psoriasis alongside improving general health. However this study suggests that due to the perceived lack of dietary support from HCPs, and indicated reliance on unsubstantiated sources for dietary advice, the majority of these dietary changes are self-prescribed and restrictive. These dietary practices could have detrimental impacts on health and well-being, and therefore highlight the need for tailored dietary support for PLwP, to provide guidance on the potential negative impacts and important considerations concerning common dietary modifications. This is critical in the face of the comorbidities. Future research should focus on the development of a tailored and evidence-based support resource to fill this dietary support need for PLwP in the UK. Further research should also investigate HCP perspectives on dietary support, and whether there is a want or need for the development of dietary support resources to help HCPs discuss diet with PLwP and combat misinformation.

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CHAPTER 5 USER-CENTERED DESIGN AND EVALUATION OF A GUIDE FOR PEOPLE LIVING WITH PSORIASIS TO NAVIGATE NUTRITIONAL INFORMATION

CHAPTER SUMMARY

In this chapter, I present a user-centred design research study conducted in response to the dietary support gaps for PLwP identified and described in the previous chapters (Chapter 3, 4 and 5). The aim of this multiphase study was to develop a user-friendly nutrition information guide for PLwP. Oversight and input from an expert panel, alongside observations of intended users (PLwP) performing tasks with the guide informed the iterative design phases and the final content and design of the guide. The guide's usability was evaluated by intended users, through a validated questionnaire. It is hypothesised that involving PLwP and an expert panel will result in the development of a dietary support resource that has good to excellent perceived usability by PLwP in the UK.

CONTRIBUTION

Poppy Hawkins: Designed the 6-phase methodology, recruited the expert panel, facilitated the expert panel discussions and recorded all feedback, conducted think aloud sessions with participants, analysed the think aloud session feedback, developed each version of the nutrition information guide using feedback from each phase of the study, and drafted the manuscript. The expert panel was comprised of 3 PLwP, 1 dermatologist, and the nutrition expertise was provided by Dr. Rosalind Fallaize, Dr. Kate Earl and Dr. Athanasios Tektonidis. The expert panel provided suggestions for scope, content and design of the guide throughout the study. Rosalind Fallaize, Kate Earl and contributed to the study design and drafting of the manuscript. All authors included reviewed and approved the final manuscript.

5.1 Abstract

Introduction: In the absence of specific dietary guidelines, and perceived inadequate dietary support from healthcare professionals (HCPs), people living with psoriasis (PLwP) often look to online platforms for dietary advice. Online dietary information is frequently inaccurate and not produced by HCPs. Following self-prescribed dietary modifications without the guidance of HCPs could negatively impact health and well-being. Therefore, PLwP need and desire support to navigate the nutritional information they may encounter, to enable them to make informed decisions. This study aimed to develop a user-friendly and evidence-based guide to help PLwP in the UK navigate nutritional information, with input from key psoriasis stakeholders.

Methods: A 6-phase User-Centered Design (UCD) approach was employed, informed by the UCD-11 framework, to design an evidence-based guide for PLwP to navigate nutritional information. An expert panel of individuals with lived experience of psoriasis, and dermatology and nutrition experts, defined the scope of the guide and reviewed all versions. The phases involved iterative design and content refinement, incorporating feedback from intended users using think-aloud methodology to design the final guide. The guide was evaluated using the System Usability Score questionnaire (SUS). Colour contrast and readability was also considered in the design.

Results: The UCD-11 framework effectively engaged intended users in the design and development of the guide. The expert panel (n=7) provided insights that enhanced the accuracy and relevance of the guide. Through think-aloud, intended users (n=7) provided real-time feedback which facilitated further refinements. The mean SUS score of intended users (n=27) was 81.1 (SD 10.7) indicating good usability, and over 70% of participants perceived the guide to be a valuable guide for nutrition information and psoriasis.

Conclusion: Involving intended users and key stakeholders through a UCD approach facilitated the development of a guide for PLwP to navigate nutritional information with good usability. This is the first study to explore approaches to address the dietary support gap for PLwP. Future research should focus on exploring the usability and value of the guide to a more diverse population of PLwP and HCPs involved in psoriasis care.

5.2 INTRODUCTION

There is an urgent and unmet need for accessible and accurate dietary support for people living with psoriasis (PLwP) (1,2). There are currently no specific dietary guidelines for psoriasis and research conducted in this area is limited (1,3). Among PLwP in the UK there is a perceived lack of dietary support from healthcare professionals (HCPs) and a desire for more dietary information from trusted sources (4,5). Research shows that although PLwP commonly seek dietary advice from HCPs central to their psoriasis care, such as dermatologists and general practitioners, these HCPs often feel unequipped to provide adequate nutritional guidance (2).

Whilst the lack of research is a valid reason for the absence of specific dietary guidelines and makes it challenging for HCPs to discussion diet and psoriasis, evidence suggests that dietary modification is common among PLwP in the UK (4,5). Furthermore, the use of alternate sources of dietary information may leave them vulnerable to misinformation (6). One of the most common sources of dietary information for PLwP in the UK are unregulated online platforms (4). Online dietary information is often inaccurate and of low quality (6). In a study that looked specifically at diet and psoriasis information on social media, most was found to be unsubstantiated, restrictive and seldom produced by HCPs (7). This may explain why PLwP often report following self-prescribed, restrictive and unsubstantiated diets (1,4,8). Following these types of diets without HCP guidance can lead to nutrient deficiencies (9–11) and can be a barrier to the adoption of healthy dietary behaviours (12,13). This is an important consideration in psoriasis care, given that psoriasis is associated with certain comorbidities, that diet may have a substantial impact on the management and progression of (14–16).

Although the need for research into diet and psoriasis is recognised (17,18) it is still an emerging area (1,3). The resources and time needed to develop disease-specific dietary guidelines and recommendations can be extensive due to the rigorous research needed to provide the necessary evidence (19,20). Whilst this is vital, it is clear that PLwP need tailored evidence-based information to navigate dietary information, to combat potentially harmful misinformation and enhance patient-centred care, in the interim. Therefore, it is essential to explore ways of developing this type of information.

When developing patient information, usability, the measure of the ease with which that information can be used is an important consideration (21,22). Patient information or health tools cannot achieve their intended aims if they are not usable by or useful to their intended users. Digital health apps and health information websites with higher perceived usability are more readily accepted by users (23,24) , and poor usability is a barrier to adopting the beneficial health behaviours the apps and patient information aim to promote (25). A further consideration is understanding (26,27). Understanding health information impacts a person's ability to manage their own health (28–30). Ensuring that information, and the way it is communicated, is at an appropriate level is vital when creating patient information to maximise accessibility and usability (26,31–33). However, designing clear and comprehensible written health information remains challenging due to differences in patient literacy levels (26,31,33). Involving individuals with lived experience in the development of evidence-based health information, can help ensure that materials are user-friendly and written at an appropriate literacy level (27). Furthermore, patient involvement is an important part of health service delivery and has been shown to enhance quality of care (34,35).

User-centered design (UCD) is an iterative methodology which involves intended users and relevant professionals in the design and development of products, services and interventions (21). This collaborative approach can aid the development of patient resources that are evidence-based, accessible, tailored to patient needs (36), and grounded in real-world experiences, all of which can enhance usability and the ability to combat misinformation (26,27,31). UCD approaches have been used to develop multiple personal health tools and patient decision aids (21,37–39) and can improve user acceptance, user-friendliness and uptake (40).

To help PLwP to navigate nutritional information and prevent the current dietary support gap from being filled by unsubstantiated or potentially harmful misinformation (6,41), evidence-based, user-friendly and tailored support is vital. Incorporating patient and public involvement and engagement (PPIE) in the design and development of such support may enhance usability and relevancy to intended users. This study focuses on developing a resource for patients, as the underpinning research is based on patient interviews and

questionnaires, exploring their views, dietary use and dietary support needs, rather than those of healthcare professionals (HCPs). The choice to prioritise a patient-facing resource aligns with the thesis objective, to develop and evaluate a user-friendly dietary support resource for adults living with psoriasis in the UK, and also aims to directly address the misinformation and unmet dietary support needs reported by PLwP throughout the studies conducted. While materials for HCPs are also important, the development of those would require research focused specifically on HCPs perspectives. As we as consideration of how those insights relate to the findings of the research presented in this thesis, both of which are beyond the scope of this study.

5.3 AIM

The aim of this study was to use user-centred design methodology to develop a guide to help adults living with psoriasis in the UK to navigate nutritional information and evaluate the usability with intended users.

This guide does not aim to fill the role of dietary guidelines. Instead, it aims to provide evidence-based information to aid PLwP to navigate nutrition information to be able to make healthy and informed dietary decisions.

5.4 METHODS

A 6-phase User-Centered Design (UCD) approach was employed to develop an evidence based guide to help PLwP in the UK navigate nutritional information. The User-Centred Design 11 framework (UCD-11) (21) provided a framework to develop the guide and a measure to quantify the user-centredness of the study. Scoring consists of 1 point for each yes to the 11 items included in the UCD-11 framework, which were whether or not: (1) potential end users were involved in steps to help the developers of the guide to understand users and their needs, (2) potential end users were involved in the design or development of a prototype, (3) potential end users were asked their opinion on protypes, (4) potential end users were observed using the tool, (5) potential end users were involved in steps intended to evaluate the tool, (6) the process had 3 or more iterative cycles, (7) changes between cycles were explicitly reported, (8) health professionals were asked their

opinion and (9) consulted before the first prototype was developed or (10) between initial and final prototypes, and (11) a panel of experts was involved.

The PPIE incorporated in this study is reported using the Guidance for Reporting Involvement of Patients and the Public long form (GRIPP2-LF) (42) this can be seen in appendix 1. For this study, the term “intended users” refers to the audience that this guide is designed for, which is adults living with psoriasis in the UK. Overall, there were 6 design phases, an expert panel (EP; n=7) defined the scope and focus of the dietary guide, provided feedback at each stage, and agreed via consensus on each version of the guide following design phases.

According to the principles of UCD-11 (21), an expert panel should include both intended users and relevant healthcare professionals (HCPs) to ensure that the design process is informed by both user needs and clinical expertise. In this study, intended users were adults living with psoriasis in the UK who were deemed experts by experience. Dermatologists, dietitians, and nutritionists were included as relevant HCPs due to their roles in managing psoriasis and dietary expertise. A total of seven panel members were recruited using purposive sampling to ensure a range of relevant expertise and lived experience. Intended users were recruited through the Psoriasis Association networks, and healthcare professionals were recruited through professional networks based on their relevant experience and knowledge in this area. There is no universally agreed-upon number for expert panels in user-centered design, panels of between 5 and 10 members are often deemed sufficient to capture diverse perspectives while remaining manageable for engagement and analysis. The size of the panel (n=7) was therefore considered appropriate to balance breadth of input with practical considerations, and was comprised of 3 PLwP, 1 dermatologist, 1 registered nutritionist and 2 registered dietitians. The principal investigator (PH) was also a registered nutritionist. The intended users were not known to each other and were not previously known to the researcher. Among the HCPs on the exert panel, one dermatologist was known to the researcher through prior professional collaboration. The dietitians and nutritionists involved were members of the supervisory team and had ongoing involvement in the research project, providing relevant expertise in line with their professional roles. Additionally, intended users provided feedback and

evaluated the guide at various phases. An overview of the methodology and phases of this study can be seen in **Table 2**.

The inclusion criteria were as follows:

Expert Panel

- Have been diagnosed with psoriasis, and/or are a dermatology professional with experience treating PLwP, and/or are a registered nutritionist or dietitian
- Are 18 years old or over
- Can read, write, and speak English fluently
- Live at a U.K address
- Have access to the internet and a device (tablet or laptop) to take part in a video call.

Intended users (Phase 3 and 5)

- Have been diagnosed with psoriasis
- Are 18 years old or over
- Can read, write, and speak English fluently
- Live at a U.K address
- Have access to the internet and a device (tablet or laptop) to take part in a video call.
-

5.4.1 Guide Development Phases

5.4.2 Phase 1: Initial guide development

The principal investigator (PH) developed a first draft of the guide using findings from recent reviews on diet and psoriasis (1,3), a qualitative study with PLwP (5) and a cross-sectional questionnaire exploring the use, experiences and perceptions of diet and psoriasis in UK adults (4).

5.4.3 Phase 2: Expert panel review initial guide

The initial guide was shared with the expert panel and feedback on the scope, language and relevance of the information included was obtained via an online meeting. Feedback

was summarised to ensure understanding and revisions were made to the guide in line with the expert panel's comments. The revised guide was then re-shared with the expert panel and consensus was obtained on the design and content, which resulted in the finalisation of the second version of the guide used in phase 3.

5.4.4 Phase 3: Think-aloud with intended users

Concurrent think aloud (CTA) methodology was used, which requires participants to verbalise their thoughts, actions and experiences while using the guide to undertake a task (43,44). Using CTA enables the capture of real-time responses and interactions with the guide, to enhance understanding of how intended users interpret the information in the context of real-world scenarios to facilitate targeted improvements (45–47).

Participants were given the second version of the guide to navigate two typical dietary recommendations for psoriasis based on findings from previous studies (1,8). As the participants performed the tasks they were asked to verbalise their thoughts concurrently on their experience using the guide, finding the relevant information, and comprehension of the information, and any other thoughts they had, out loud. Two dietary scenarios were used in this phase to understand how intended users used the guide for different types of dietary modifications. Dietary scenario 1 was a restrictive dietary modification and dietary scenario 2 was a dietary modification that suggested following a specific diet. Following the dietary scenario task, participants were asked open-ended questions to further explore their perceptions of the guide, obtain feedback for improvement, and to identify dietary concerns that may not have been included in the guide. This phase was conducted online via a 1-to-1 Zoom call with the principal investigator (PH) and lasted approximately 1 hour. The audio and video of each call were recorded and transcribed. The think aloud scenario tasks and further questions can be found in appendix 2. Participant numbers for this phase were based upon those required to find most of the usability issues using think aloud methodology (48,49).

5.4.4.1 Analysis

The recordings and transcripts of the think aloud phase were analysed using thematic analysis (50), to identify common themes, areas of feedback, difficulties experienced and ideas for improvement. All transcripts were coded in NVivo software. The findings were then used to refine and inform the third version of the guide.

5.4.5 Phase 4: Final guide design via consensus

The principal investigator (PH) revised the second version of the guide using findings from Phase 3. This resulted in the third version of the guide, which alongside a summary of the feedback obtained in Phase, was shared with the expert panel. The expert panel provided feedback on the revised guide and revisions were made in line with these to produce a final version of the guide. This was re-shared with the expert panel and the final guide design was agreed upon via consensus.

5.4.6 Phase 5: Usability evaluation

The system usability scale (SUS) (51) was used to assess the perceived usability of the final guide by intended users. Participants used the final guide with dietary scenario task questions and completed an online SUS questionnaire. The SUS is a widely used, validated usability scale (52,53). It consists of 5 positively worded statements and 5 negatively worded statements answered on a 5-point Likert scale (ranging from strongly disagree to strongly agree) to assess perceived usability of a system or product (51). The statements were adapted for relevance to this study by replacing “this system” with “this guide”. Participants were then presented with a further 2 Likert scale statements on the perceived value and use of the guide specifically for nutrition and diet information. The SUS questionnaire and perceived use and value questions can be seen in appendix 3. Participant numbers for this phase were based upon participant numbers recommended for usability testing (54,55).

5.4.6.1 Analysis

The SUS is scored between 0 and 100, with a higher score indicating higher perceived usability (51). The final score for each SUS questionnaire was calculated as follows: X = the sum of the points for all odd-numbered (positive) questions - 5, Y = 25 - sum of the points for all even-numbered (negative) questions. SUS score = (X + Y) × 2.5 (51). The mean SUS score was calculated and interpreted using the adjective ratings seen in **Figure 1.** (56). Descriptive statistics were used to report answers to the 2 further Likert scale questions.

Figure 1. Shows the adjective ratings of SUS scores compared to quartiles (56). A mean SUS score of 68 is a widely recognised and commonly used benchmark for usability, as it falls at 50th percentile of data from a large number of studies using SUS (57,58). An SUS score below 68 would be considered below average, and a score above this would be considered above average. However, more detailed interpretations of SUS scores provide additional insights into usability (56). Typically, a score below 50 is deemed unacceptable with a poor usability rating, a score above 70 is considered acceptable with good usability, with a score equal or above 85 considered to have excellent usability, and a score of 100 being the best imaginable usability (56) .

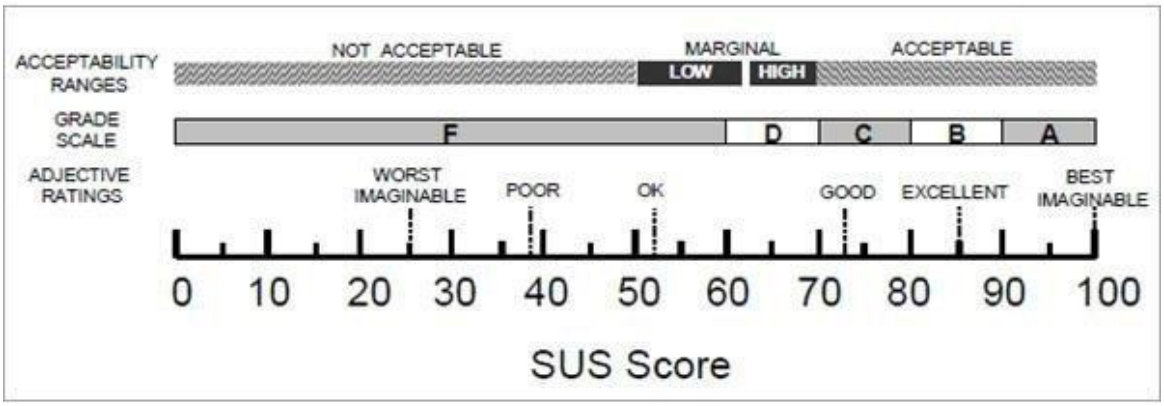


Figure 1. Shows the adjective ratings of SUS scores compared to quartiles (56).

5.4.7 Phase 6: Accessibility assessment

Accessibility was considered throughout the design of the guide and assessed in the final guide. Readability is an objective measure of how easy a piece of text is to read and is often

described using a school-age reading level. It is a key consideration when producing health information (26,27,59). Colour contrast between text and background can affect some people's ability to comprehend information and impacts usability (60–62).

5.4.7.1 Readability

The concept of readability indicates how easily information can be understood by a lay audience and is an important contributor to patient understanding (32).The NHS and the National Institute for Health and Care Research (NIHR) recommends that patient information should be written for a reading age of 9 to 11-years-old, and when necessary medical terms increase the reading age, 11 to 14-years-old is recommended (26).

The readability of the guide was assessed using the Flesch Reading Ease (FRE) (63), Flesch–Kincaid Grade Level (FKGL) (64), and the Simple Measure of Gobbledygook (SMOG) (65) formulas. These metrics were chosen because they are validated for use on text in English, widely used and are recommended by Health Education England (HEE) (66). They also provide a readability score in age level equivalents, allowing for meaningful comparisons with recommended reading age levels. The readability scores were assessed through the Readable website (https://readable.com) (67). All of the text from the guide was entered into readable.com and the FRE, FKGL and SMOG formulae were utilised to assess the readability of the written content. The scores were then compared with the NHS and NIHR recommendations (26,27,66). The readability scores are calculated based on textual parameters such as sentence length, frequency of complex and polysyllabic words. The formulas for each readability test can be seen in **Table 1.** All of the readability tests provide a score that equates to an American school grade reading level, which can be assigned to an equivalent reading age in the UK (63–65).

Table 1. Readability assessment tests and their formulas used to assess readability of the nutrition navigation guide for PLwP developed using UCD.

Readability Test	Formula
Flesch Reading Ease (FRE) (63)	206.835 – (1.015 x average sentence length) − (84.6 x syllables/word)
Flesch-Kincaid grade level (FKGL) (64)	(0.39 x average sentence length) + (11.8 x syllables/words) − 15.59

Simple Measure of Gobbledygook (SMOG) (65)	$3 + \sqrt{}$ of the number of words with 3 syllables or more

5.4.7.2. Colour Contrast

The Web Content Accessibility Guidelines (WCAG) (61) provides technical specifications to improve the accessibility and provides recommend minimum levels for colour contrast between text and background, to ensure information can be read by people with moderately low vision. The WCAG Contrast (Enhanced) level AAA, the highest standard, requires the visual presentation of text and images of text to have a contrast ratio of at least 7:1 (61). The Web Accessibility in Mind (WebAIM) website https://webaim.org/resources/contrastchecker/ (68) an online colour contrast checker tool, was used to assess whether the guide met the WCAG level AAA threshold.

Recruitment

Participants were recruited via promotion through The Psoriasis Association channels, online via social media, and through word of mouth. The expert panel recruitment also involved contacting healthcare professionals with expertise and interests in diet and psoriasis.

Ethical Approval

Ethical Approval was granted by The University of Hertfordshire, Heath, Science, Engineering & Technology Ethics Committee with Delegated Authority. Protocol number: LMS/PGR/UH/05501(1)

Table 2. Description of each phase of the 6-phase UCD methods utilised to develop a nutrition navigation guide for people living with psoriasis. The methodology used in this study was based on UCD-11 framework to enhance user-centredness of the methods and guide

Phase	Methodology	Participants	Actions
1	**Initial guide development**	**Principal investigator (PH)**	**► Principal investigator (PH) uses previous research and literature on diet and psoriasis to inform the development of an initial guide.**
2	**Expert panel review initial guide**	**Expert Panel of psoriasis stakeholders**	**► Principal investigator (PH) shares the initial guide with the expert panel.** **► 1-hour Expert Panel Discussion** ➢ Online meeting facilitated by PH to discuss the first draft. ➢ The expert panel provides feedback on the scope, language and relevance of the information included in the guide. ➢ Feedback is recorded, collated and a summary is checked with the expert panel for understanding. **► Initial guide developed using feedback from expert panel discussion.** **► The initial guide is sent to the expert panel to check feedback had been incorporated accurately and consensus achieved on design for Phase 2.**

3	**Think Aloud with intended users**	**5-10 intended users who meet the following inclusion criteria**: - Have been diagnosed with psoriasis - Are 18 years old or over - Can read, write, and speak English fluently	► **Recruit participants that meet the inclusion criteria.** ► **Principal investigator (PH) conducts 1-hour think-aloud sessions 1-1.** ➢ Participants use the initial guide with the "real-world" dietary scenario task. ➢ Participants verbalise their thoughts and experiences when using the initial guide to navigate the dietary scenarios.
		- Live at a U.K address - Have access to the internet and a device (e.g., a tablet or laptop) to take part in a video call.	► **PH interviews the participants after the think-aloud session.** ➢ Participants asked about their experience using the guide and to provide any further feedback and ideas to improve the initial guide. ► **Analyse the think-aloud exercise and interviews.** ► **Use the analysis to develop a second version of the guide.**

4	**Final guide design via consensus**	**Expert Panel of psoriasis stakeholders**	**► Principal investigator (PH) shares a revised version of the guide, which incorporates findings from Phase 2, with the expert panel.** ➢ PH provides summary of Phase 2 findings and how these have been incorporated into the revised version. ➢ PH provides a list of remaining issues and any questions for expert panel. **► Expert Panel provides feedback and discusses questions with PH.** **► Principal investigator (PH) uses the feedback from the expert panel to develop a near-final version of the guide.** **► Principal investigator (PH) shares the near-final version of the guide, to check feedback has been incorporated accurately and consensus is achieved on the final guide design.**
5	**Usability Evaluation of the guide by intended users**	**20-30 intended users who meet the following inclusion criteria**: -Have been diagnosed with psoriasis -Are 18 years old or over	**► Recruit participants that meet the inclusion criteria.** **► Participants use the final guide with "real-world" dietary scenario tasks.**
		-Can read, write, and speak English fluently -Live at a U.K address -Have access to the internet and a device (e.g., a tablet or laptop) to take part in a video call.	**► Participants evaluate the final guide by completing the System Useability Scale (SUS) questionnaire to assess the user's perceived usability of the guide.** **► Participants asked 2 Likert scale questions on the usefulness of the guide for nutrition and diet information and perceived value of the guide.** **► Analyse the SUS questionnaires and Likert scale questions.**

			► **Use UCD-11 to measure the user-centred design score for the methodology.**
6	**Accessibility Checks**	**Principal investigator (PH)**	► **Run readability formulas on the written content of the guide.** ► **Conduct colour contrast checks on all colours used in the guide.**

5.5 RESULTS

5.5.1 Phase 1: Initial guide development

The initial guide was developed using previous research in the area (1,3–5) and resulted in a 2page document of written information, titled “Navigating Nutrition for Psoriasis”. It contained sections on diets, cutting-out specific foods and further information and support. The initial guide provided a useful first step to facilitate discussions on the guide's scope and content with the expert panel. The first page of the initial guide and final guide can be seen in **Figure 2.**

5.5.2 Phase 2: Expert panel review initial guide

The expert panel agreed that the nutrition navigation guide should provide PLwP with clear and simple information about dietary recommendations they might come across. It was agreed that the guide should be increased to 4 pages that can be viewed online, with the possibility of being printed off. The key considerations and agreed suggestions from the expert panel discussions on the initial guide can be seen in **Table 3.** These were used to develop the second version of the guide for Phase 3.

Table 3. Modifications to be made to the nutrition navigation guide for people living with psoriasis agreed by the expert panel in Phase 2.

Theme	Agreed revisions to develop second version of the guide
Information Identification	
Make information easy to identify	• Make the title larger and clarify what the guide is helping people to navigate. • Addition of diagrams and visual aspects. • Make clearly labelled sections for each dietary modification type. • Space out the text more and increase to a 4-page guide.
Highlight key information	• Make key information clear to users throughout the guide. • Provide tips to help users follow the information provided.

Language	• Ensure the language is simple and clear but avoid patronising tones. • Provide simple explanations for specific terms (e.g., nightshades, coeliac disease). • Keep language consistent to enable users to be able to follow and identify key information e.g., including "what does the research say" sections for each diet.
Information Content	
Information on nutrition	• Ensure that users are aware of the food groups and the important nutrients that they may be cutting out if they follow certain dietary modifications. • Provide clear and useful examples of how users can fill certain nutrient gaps. • Provide support on cutting-out foods beyond stating the evidence. Users may be likely to try cutting out a range of foods and need more explicit guidance on how to do this as safely as possible.
Information beyond the guide	• Provide links to further credible resources for users to visit rather than including all information in the guide, as this makes the amount of information overwhelming. • Integrate the links in the relevant dietary modification sections. • Produce a section to support users if they come across a dietary modification for psoriasis not mentioned in the guide.

	• Highlight that other diets may be suggested to users beyond this guide and create a specific section to highlight factors users should be aware of if they come across other dietary suggestions.
	• Include a section to further psoriasis specific support (e.g., psoriasis organisations).
General Design	
Accessibility	• Use less colours and make colour combinations simple. • Ensure colour contrast is accessible. • Make the text larger and ensure the title is clear and large. • Provide a brief summary of the guide, to let users know what this guide is for.

5.5.3 Phase 3: Think Aloud with Intended Users

Overall, 7 participants took part in Phase 3 (5 females and 2 males). The demographic information of the participants is summarised in **Table 4.**

Table 4. Phase 2: Think Aloud participant demographics

Participant	Age group	Sex	Ethnicity	Psoriasis severity	Highest level of education
1	35-44	M	White	Moderate	GCSE
2	65+	M	White	Mild	Degree
3	25-34	F	Indian	Moderate	Degree
4	25-34	F	White	Moderate	Degree
5	25-34	F	White	Mild	Degree
6	25-34	F	White	Moderate	Degree
7	45-54	F	White	Severe	A-level

Observing intended users interacting with the guide through CTA, allowed for increased understanding of user experiences and interpretation of the information to identify usability

issues. These included aspects of the guide that lacked clarity or were hard for intended users to understand. The thematic analysis of the concurrent think-aloud tasks and the subsequent semi-structured interviews led to the identification of four main themes referring to the usability and value of the guide by intended users; (1) Information retrieval, (2) Specific usability aspects including clarity of wording, content, and layout and design, (3) The perceived value of the guide, and (4) Suggested changes to improve usability and value.

Theme 1: Information retrieval

Participants struggled to find information on the potential dietary implications of cutting out or reducing meat. They were able to identify the vegan section and information on red meat but nothing on all types of meat.

> ***P5: "****I can't find what the meat said. Anything about nutrients. I remember the red meat.."*

> ***P4:*** *"red meat. Would that [information] be in like the Vegan diet?"*

Participants identified all of the other information required to answer the task questions. As well as being able to confidently point out where they could go for more information on specific dietary areas.

> ***P1:*** *"Make sure we eat enough fibre. Then I'd go to this link here [.....] Which I assume would maybe have that information on where I could get more fibre from.*

Participants were able to confidently and correctly state the nutrients that may be missing if they followed certain diets, and how they could fill these potential nutrient gaps if they did trial these diets by using the guide.

> ***P3:*** *"with [cutting out] diary it would be protein, vitamin B, calcium and iodine...If I was considering this [restrictive diet], I would really need to check that I still have a balanced diet. So like making sure I still get nutrients. I need to maintain my health because I can clearly see cutting out everything at once is a risk of potential harm to yourself."*

P7: *"[you'd have to get] the calcium and the other vitamins that you get in dairy from somewhere else, so you can't just cut out dairy, because that's you know you're missing a whole food source there, that is really important…"*

Using the guide, participants were also able to identify red flags from the dietary task scenarios they were given.

P5: *"Yes, straight away. It's saying, can cure your psoriasis, whereas in the guide, like at the bottom, it made it very clear that you know it's a red flag…."*

Theme 2: Specific usability aspects

Overall, participants were very positive about key usability aspects of the guide. This included clarity of wording, the amount and depth of the information given, and the layout and design of the guide.

Clarity of wording

P1*: "I think it's really clear, not too scary [……] Yeah, the colours are good. I think it's good that it's only like, not many pages and it's big. It's clear. Yeah, I think it's a really a good guide."*

P3: " *clearly written, which is really nice, because then you can just find it very easily. It's like, it's the best summary for each diet. It's not simple, but it's more like informative in a way that it doesn't overload the people reading it."*

Information

P1: "*I think there's a lot of good information without being too overwhelming. [….] Even say, my daughter is 10, you know. I think that she could probably, take this in and understand it as well as you know, people who are older as well."*

P3: *"It's not simple, but it's more like informative in a way that it doesn't overload the people reading it."*

P6: "there's so much misinformation online, especially on social media and stuff like that. And at the end, you know, you've put there is no cure, and that's key, you know. It's just managing it and lots of people try and get quick fixes. Just first impressions is that this is brilliant. It's such a balanced guide."

Layout and design

P2: *"first of all, it's very readable in terms of the, it's illustrated with colours, pictures, short statements. So it's very good in that respect. It's kind of broken into sections. So if you came across the diet you, you could say well, quite quickly, find them in there and draw out the information you need.*

P4: *"*..... you do the little sections. So I think that's really nice, as well, it kind of breaks it down for people"

P5: *"You knew which section you needed to find on the guide to really solve each sort of elements like the Mediterranean diet, the dairy free is so clearly labelled and sectioned off, and quite so clear."*

Theme 3: The perceived value of the guide

Participants commented on the value of having this guide. They often stated that this type of guide would have been useful for them, especially when they were first diagnosed with psoriasis. Participants also stated that they learnt things from the guide about common dietary recommendations they had seen or been suggested for psoriasis. Participants also felt that the guide would give them a sense of empowerment to be able to make decisions on diet, and enable them to do something to help themselves.

P1: *"…. when you cut out dairy, I think you know about milk and calcium right? But I didn't really know about B12 or iodine."*

P5: *"[it's useful] to know whether to take something with a pinch of salt or be like oh, actually, they might be onto something here, and that you sort of have a first initial point to sort of go to for reference, and then decide whether you want to look into it further.*

P7: *"Definitely useful, definitely. Good sign posting to have. Because, trust me, trying to find information out there that you can rely on is really tough.....So it would be a really good way to have that bit of empowerment and people to say, Okay, so maybe I can try and help myself a little bit. So they've got some information to go with that's credible..."*

P7: *"I can see it being a really useful tool, and especially even for people, I mean who been doing this a while now, and I feel I'm quite knowledgeable in what I've done so far, but somebody just coming off the blocks. This is honestly, this would be invaluable. Really.*

Theme 4: Suggested changes to improve usability and increase value

Participants also gave insightful and constructive suggestions on what could be done to improve the guide.

Participants suggested adding in more information on meat generally, rather than just focusing on red meat. More information on reducing sugar intake was also suggested, as people mentioned that they knew this was a positive thing to do but were unsure of how to go about it, or the recommendations on intake.

P2: *"maybe a comment on red meat versus white meat, something like that might just help, but without going into huge detail"*

P6: "some more about sugar [.....] maybe some sign-posting"

Participants suggested providing further information on dietary terms they commonly saw regarding diet and psoriasis, but were not included in the guide (e.g., anti-inflammatory). Participants stats that these often caused confusion and were used as a buzz word to draw people with psoriasis in. It was also suggested that including a warning about information

on social media and other dietary trends commonly targeted towards PLwP would be useful.

> ***P4:*** *"as well as like the anti-inflammatory diet. Now, I don't really know much about that, but I see it, I think, like the word inflammation kind of draws people in..."*
>
> ***P6:*** *[highlight the importance of] "using caution on social media. So, I think that might be good to include in the red flags [as well as] cleanses and green juice, and celery juice to include in the red flags."*

Participants suggested improving the visual look of the further information section to grab attention, with logos suggested as an idea that would also improve impact through people recognising the logos as a trusted resource.

> ***P2:*** *"putting the logo there would be even better because once again people recognise logos."*
>
> ***P3:*** *"[using the logos would give people] like a bit of reassurance that it is something legitimate rather than just some random thing that's on the Internet ..."*

Regarding the title, participants generally liked the title and thought it was appropriate. However, some thought it was a bit long and suggested making psoriasis the first word or failing that suggested making "psoriasis" bolder to standout on the guide. As this was something they would look out for if they were searching for information.

Key changes made to the guide using the findings from the Phase 2: Think Aloud Feedback

- Psoriasis was made clearer in the title of the guide.
- Specific information on reducing or cutting out meat (white and red) was added via a vegetarian diet and "plant-based" diets section.
- Information on anti-inflammatory diets and psoriasis was added.
- Extra icons to highlight key tips and links were incorporated.
- Extra links to information on cutting down on alcohol and sugar were added.

- Cautions about social media information, juice cleanses, and detox diets were added to the red flags section.
- Space for logos of psoriasis support organisations were made in the further information section.

5.5.4 Phase 4: Expert Panel Review Second version

The expert panel (EP) reviewed the third version of the dietary guide, which was revised using the phase 3 findings, and provided feedback to further refine it. Overall, the EP thought the revised guide was an improvement and incorporated the feedback well. The EP also provided several suggestions to further refine the guide, presented in **Table 5.** These revisions were agreed upon and then incorporated into the guide's final design. The final guide design was then approved by the panel, ready for Phase 5, the full final guide can be seen in appendix 4.

Table 5. Key considerations for nutrition navigation guide for people living with psoriasis agreed by the expert panel following the third version of the guide incorporating Phase 3: think aloud findings.

Theme	Agreed revisions to develop second version of the guide
Information Identification	
Make information easy to identify	• Make "psoriasis" stand out more in the title. • Use a clearer word than navigate. • Follow a more logical order of diets in the "diets" section, with the least restrictive first.
Language	• Consistency needed for language within sections. • Suggestions to improve grammar of the information. • Suggestions around wording for anti-inflammatory to keep simple but accurate.
Information Content	

Further information	• Adding a sentence in the weight-loss section, about improving general health too, given the association between psoriasis and certain comorbidities. • To keep information evidence-based and balanced add a short sentence on the potential benefits of eating a small amount of red meat for certain populations.

5.5.6 Phase 5: Evaluation of the usability of the guide using SUS

In total 27 participants evaluated the guide using the SUS and completed the further two Likert questions. The demographics for which can be seen in Table 6. Only fully completed SUS questionnaires were analysed, as the SUS score is depended on all 10 questions being answered.

Table 6. Demographics of participants in Phase 4: Evaluation of the final guide using SUS

Characteristic	
Age (years), mean (range)	43.8 (25-69)
Sex, n (%)	
Female	20 (74.1)
Male	7 (25.9)
Education, n (%)	
University degree	18 (66.7)
A-level	3 (11.1)
GCSE	6 (22.2)
Psoriasis Severity, n (%) **Mild**	5 (18.5)
Moderate	17 (63.0)
Severe	5 (18.5)
Ethnicity, n (%)	
White	26 (96.3)
Other	1 (3.7)

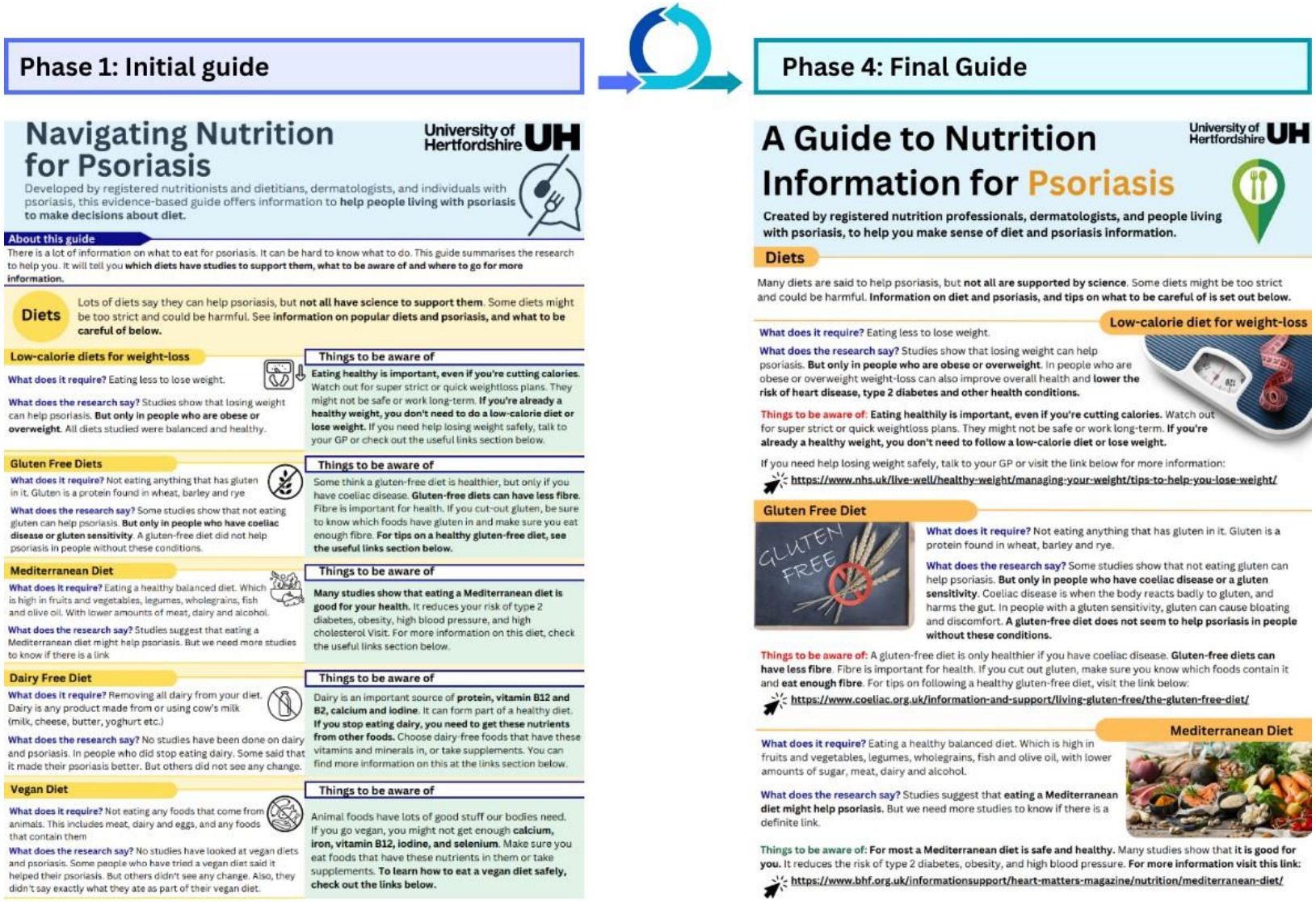
The mean score of the SUS was 81.1 (SD 10.7), indicating that the guide had good perceived usability by intended users (56). Regarding the two additional Likert statements

on the perceived use and value of the nutrition and diet information, 70.4% of the participants strongly or somewhat agreed that the guide was useful to help them make decisions about diet and psoriasis and 74.1% strongly or somewhat agreed that the guide was valuable to help people make informed decisions about nutrition and diet to manage their psoriasis symptoms (**Table 7**.).

Table 7. Results of the additional 2 Likert statements participants answered following the use of the guide

Statement	**5-point Likert scale response, n (%)**		
	Strongly disagree and somewhat disagree	Neutral	Strongly agree and somewhat agree
I found this guide useful to help me make decisions about diet and psoriasis	5 (18.5%)	3 (11.1%)	19 (70.4%)
This is a valuable guide to help people make informed decisions about nutrition and diet to manage their psoriasis symptoms.	3 (11.1%)	4 (14.8%)	20 (74.1%)

Figure 2. The first page of the initial guide developed in Phase 1, and the first page of the final guide which was produced through multiple iterative design phases and finalised via consensus between the expert pane in Phase 4.



UCD-11 Score

The methodology used to design and develop the guide met 11 out of the 11 criteria for user-centred design according to the UCD-11 item measure (UCD-11).

5.5.7 Phase 6: Accessibility Assessment

Readability

The readability assessment of the guide's written element indicated that the text is understandable for those with a reading age between age 10 to 14 years. Among the different readability formulas, the SMOG Index reported the highest reading age, assessing the text to be a reading age level of 13 to 14 years old. The Flesch-Kincaid Grade Level assessment was the only score to align with the recommended reading age of 9 to 11 years old. However, the words psoriasis, dermatologists, Mediterranean, vegetarian, and inflammatory were considered hard to read words, increasing the reading age across all the scores. In cases where more complex words are necessary in patient information, a reading level of 11 to 14 years old is considered acceptable (26,66), and all readability scores fell within this range (Table 8.).

Table 8. The score of each formulae used to assess the reading age level of the text included in the final version of the guide, and the equivalent UK reading ages.

Readability Assessment	Score	Equivalent UK reading age
Flesch Reading Ease (63)	70.1	7th Grade = 12-13 years
Flesch-Kincaid grade level (64)	5.9	5-6th Grade = 10-12 years
Simple Measure of Gobbledygook (65)	8.9	8th grade = 13-14 years

Colour contrast

All of the colour contrasts of the final guide met the enhanced WCAG Level AAA, which requires a contrast ratio of at least 7:1 for normal text and 4.5:1 for large text (61).

5.6 DISCUSSION

This study employed UCD methodology, informed by the UCD-11 framework, to develop a user-friendly nutrition navigation guide for PLwP in the UK. Using a UCD approach to understand the context specific dietary support needs of PLwP and employing iterative design cycles allowed the requirements of intended users to be implemented into the design, resulting in good usability scores, and positive feedback on usefulness and value of the guide. The guide also met all accessibility criteria on readability (26,66) and colour contrast (61).

Using concurrent think-aloud methods in phase 2 allowed for the identification of key usability issues of the guide, alongside specific elements that participants thought enhanced its usability. Participants thought that including pictures and visual cues made the guide more visually appealing and facilitated easier navigation and information retrieval. This preference for visual aids aligns with findings from other studies, which have indicated that visual elements improve usability and understanding, and are frequently desired by patients (69,70). Moreover, clear and appealing pictures in health communication can make information more engaging (66,71) and enhance effective delivery of health messages to non-experts and (60,71,72). Participants also valued the use of balanced language that was simple and informative, but not patronising, a key recommendation of NIHR and NHS guidelines for patient information (26,27,66), which emphasises the importance of simple yet informative communication in patient information.

A key finding from phase 2 was the value that participants put on dietary information that is specifically tailored to psoriasis. Referring to information on dietary suggestions commonly seen in the psoriasis community or frequently suggested to PLwP. They also thought that the value and usefulness of the guide could be improved by providing more tailored guidance on specific types of diets frequently recommended within the "psoriasis community", such as anti-inflammatory diets and detox cleanses. This highlights the importance of providing tailored dietary support rather than general healthy eating advice alone, to meet the needs of PLwP and combat the abundance of misinformation. This tailored support was also perceived to be valuable to people who have been recently diagnosed with psoriasis, as they may feel overwhelmed by the amount of dietary

information available, coupled with the lack of professional support. The inclusion of this type of dietary support may explain why over 70% of participants agreed that the guide was useful and valued. These findings align with previous research which demonstrated that PLwP perceive there to be a lack of dietary support, which when it is provided is often limited to vague and unhelpful general healthy eating advice(4,5). Although healthy eating is an important public health message to get it across, it does not fully address the specific support needs of this population, which may leave them open to misinformation. This desire for specific, patient-centred, tailored dietary support to combat the abundance of confusing information has also been highlighted in other conditions where dietary misinformation is common (13,73,74).

A further suggestion to enhance the guide's impact is the inclusion of logos from trusted psoriasis organisations or regulatory bodies. This could serve as a mark of reliability, helping users to distinguish evidence-based information from the vast amount of misinformation available, which often appears equally credible. Given the prevalence of misinformation, which was acknowledged by the participants, such visual endorsements could help ensure the trustworthiness of the information provided (75).

Regarding usability there are several considerations to take into account. Although the guide demonstrated good usability, this does not guarantee high acceptability in the real world (56). Therefore, further research is needed to explore if intended users would utilise the guide, and how it would stand up in the face of the plethora of dietary information in the real world (6,41,76). This would provide deeper insights into the guide's practical use and acceptance. Moreover, examining the impact of the guide could shed light on whether usability is linked to improved dietary decisions and perceived feelings of adequate dietary support, in the context of diet and psoriasis.

Additionally, understanding the value and utility of the guide from the point of view of HCPs involved in psoriasis care would provide a comprehensive view of the usefulness and value of the guide. Given that many HCPs have reported feeling inadequately equipped to provide dietary support to patients (2), future research should investigate whether this guide could

serve as a useful resource to address this gap in the interim of more robust research into diet and psoriasis.

Regarding readability, scores varied depending on the assessment metric used. The reading age was increased across all metrics due to words that were highlighted to be difficult words, due to their complex nature or amount of syllables. This applied to both psoriasis and dermatologists, which although complex and polysyllabic, it is likely that these words are more familiar to this population due to the care provided by dermatologists. Excluding the word psoriasis would have been detrimental, as it would not have been clear what the guide's purpose was, which would likely reduce understanding and use by the target population. Furthermore, the specific words for common diets they may come across is important to name, as these are the terms PLwP are likely to encounter in real-world contexts.

5.7 STRENGTHS AND LIMITATIONS

Limitations

A key limitation to this study was that the guide was primarily designed with input from, and evaluated by, white females, which could introduce bias and limit the generalisability of the usability score of the guide. The PPIE aspect required participants to have access to a device and internet connection, which may have limited participation. Evaluating the perceived usability with a more diverse group, could enhance understanding of the usability in other groups and is an area for future research. The SUS has some limitations which should be considered when evaluating usability. Although the SUS score gives an overall indication of usability, it is unable to identify specific areas of the guide, system or product being evaluated, that are causing users issues or are lowering the usability. Following the SUS with further questions or individual interviews could have provided more insight into issues users faced, or reason that the usability was marked down.

Furthermore, the SUS scores are self-reported, which means that even if users perceived the guide to be user-friendly, they may not use it correctly or fully comprehended the

information provided, which could lead to variability in usability scores. Participants may also have had an interest in diet and psoriasis, with prior knowledge, meaning that they were able to understand the information provided due to previous knowledge and not necessarily due to the guide being user-friendly. This may have led to inflated perceived usability.

Strengths

To the best of our knowledge, this is the first study to explore an approach to addressing the dietary support gap for PLwP. Using a UCD approach and incorporating PPIE in the creation of a dietary information guide specifically tailored to PLwP the study offers valuable and key insights in advancing the understanding and development of dietary support tools for PLwP. This represents a crucial step toward addressing the gap in dietary support for this population and establishes an important standard for the development of future support and patient information for this population, and potentially beyond in other conditions. The study's strength lies in its integration of both expert panel insights and the active involvement of intended users, which provided a comprehensive perspective that informed the development of the guide. By employing 1-1 concurrent think-aloud methods with follow-up questions the study allowed for the collection of in-depth feedback on the guide. Furthermore, the use of a validated and widely used evaluation method, the SUS, enabled a validated evaluation of usability that allowed for direct comparison of the guide's usability against established benchmarks for other tools and resources.

5.8 CONCLUSION

This study is the first to explore dietary support solutions among adults with psoriasis in the UK. Employing user-centred design methodology and incorporating PPIE led to the development of a nutrition guide specifically tailored to PLwP, with good usability that was perceived to be both valuable and useful to intended users. This study contributes to the wider area of integrating nutrition support, and patient-centred care, highlighting the importance of tailoring solutions to patient needs. Future research should explore the

perceptions of a more diverse population and healthcare professionals involved in psoriasis care, as well as asking participants to provide qualitative insights in the answers given in the SUS. This will enhance understanding of the guide's suitability and identify additional insights that may further improve the guide's value and usability.

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CHAPTER 6 DISCUSSION, CONCLUSION AND FUTURE RESEARCH

CHAPTER SUMMARY

In this chapter I present a summary of the findings of this thesis. I discuss how the findings contribute to the overall narrative of the thesis and their implications and relevance within the context of the wider research field. In this chapter I also reflect on the limitations of the research presented in this thesis and introduce areas for future research.

6.1 INTRODUCTION

Despite the high demand for dietary information on psoriasis, there are no dietary guidelines, and limited research has been conducted in this area (1). This knowledge gap highlights the need for comprehensive research to better understand how to support PLwP in the absence of specific dietary guidelines. Thus, the objectives of this thesis were to (1) systematically review the current literature on diet and psoriasis; (2) explore the experiences, utilisation and perceived effectiveness of dietary modifications among adults living with psoriasis in the UK and (3) develop and evaluate a user-friendly dietary support resource for adults living with psoriasis in the UK. This chapter will summarise the findings and discuss their contribution to the wider research field. Additionally, recommendations for future research are set out.

6.2 SUMMARY OF FINDINGS AND DISCUSSION

This thesis employed a mixed-methods research approach. Overall, four studies were conducted to achieve the objectives. The findings provide a unique contribution to the current evidence on the role of diet in the management of psoriasis, through mapping the current evidence, exploring the dietary practices and perceptions among PLwP in the UK, and highlighting areas for future research. Furthermore, the findings identified a substantial dietary support gap within psoriasis care and informed the exploration of a potential solution; the development of a dietary support guide tailored to PLwP. The findings offer a practical solution to the support gap identified and pave the way for future research to address existing knowledge gaps and improve patient care.

To provide a comprehensive understanding of the field and ensure that the subsequent research was grounded in existing evidence, a systematic scoping review was conducted (Chapter 2). The review is the first of its kind to include a broad range of studies, alongside grey literature, thus offering a uniquely comprehensive overview of the literature from randomised controlled trials (RCTs) to psoriasis guidelines. A key finding of the scoping review was the identification of a gap in robust evidence for diet in the management of psoriasis (2). Except for low-calorie diets in people living with overweight or obesity, and GFD in coeliac or those with a gluten sensitivity, research into other dietary modifications is

either inconclusive, methodologically heterogenous or non-existent (2). Furthermore, patient information was found to be lacking in dietary support. Although the aforementioned diets are supported by evidence for their efficacy in certain psoriasis populations, there is a notable lack of information on the healthy implementation of these diets. This finding indicates that individuals outside of the above criteria are left without any evidence-based dietary information, and for those who do fall into the above categories an assumption that they possess the necessary knowledge to follow them safely and effectively. There is also no guidance if PLwP seek support beyond these two dietary modifications. This may make it challenging for HCPs involved in psoriasis care to provide dietary support to patients beyond these diets. This is concerning considering the findings of Chapter 3 and 4 which suggest that PLwP in the UK frequently trial dietary modifications beyond a GFD and weight loss. This highlights the need for more robust research investigating the impact of a broader range of dietary factors on psoriasis, and exploration of dietary support solutions for PLwP.

The findings of the scoping review (Chapter 2), Chapter 3, and Chapter 4 highlight potential dietary factors that warrant further investigation into their impact on psoriasis. The scoping review revealed cross-sectional studies on the MD and psoriasis show promising results, with all identified studies demonstrating an association between higher adherence to the MD and lower severity among a psoriasis population. The MD has been shown to have anti-inflammatory properties (3,4), which may go part way in explaining this. However, cross-sectional studies are limited by their inability to show cause and effect. Moreover, strong evidence demonstrates that adhering to a MD can reduce risk factors associated with various psoriasis-related co-morbidities (5). Considered together, understanding more about adherence to the MD and impact on psoriasis severity could help inform comprehensive dietary recommendations for PLwP. Longitudinal studies that investigate the relationship between adherence to the MD and the onset and severity of psoriasis would provide insights into how MD adherence may influence psoriasis over time. Additionally, RCTs investigating the impact of the MD on psoriasis severity would provide more robust evidence regarding the impact of diet on psoriasis. This finding also suggests a

potential role for other anti-inflammatory dietary patterns in psoriasis management. In particular those shown to provide broader health benefits, relevant to the co-morbidities of psoriasis, for example the dietary approaches to stop hypertension (DASH) diet (6). Initial observational studies exploring DASH and psoriasis may indicate whether further investigation is necessary. This is a key area of future research towards the development of comprehensive dietary recommendations for managing psoriasis alongside the comorbidities and promoting overall health.

Furthermore, through novel exploration of the dietary practices of PLwP in the UK and their reported impacts on psoriasis (Chapter 3 and 4) this thesis demonstrates that unsubstantiated restrictive dietary modifications are common among PLwP in the UK. Cutting-out dairy is one of the most common dietary modification tried by PLwP in the UK (Chapter 4). The findings of the questionnaire revealed those in the younger age group, and those with more serve psoriasis were more likely to try following a dairy-free diet. However, there is large variability in the reported individual responses to this dietary modification; 53% reported that a dairy-free diet improved their psoriasis symptoms, yet 42% reported no change. This has also been shown to be the case in other populations (7). Although these results are self-reported, they provide a unique insight into the prevalence of dairy restriction among PLwP and suggest that its effects on psoriasis symptoms are varied. Concerningly, the scoping review (Chapter 2) did not identify any studies that investigated the impact of dairy on psoriasis. This underscores that unsubstantiated diets are frequently adopted by PLwP, regardless of the supporting evidence.

These findings indicate the need for studies to better understand the impact of dairy restriction on psoriasis and micronutrient intake in PLwP. Dairy products provide key dietary micronutrients (8–10) and in people with other conditions who follow elimination diets, commonly excluding dairy, have been found to have lower intakes of key micronutrients (11). The specific type of dairy was not considered in the questionnaire conducted in this thesis; highlighting an area that warrants further investigation, as there are a wide range of foods included under the term dairy (12). Each type has varying macro- and micronutrient composition, and therefore subsequent impacts on health (10,12). Research also suggests

that dairy may have beneficial impacts on inflammation (12–14) and as part of a healthy diet, may be protective against type 2 diabetes and CVD (15,16). Therefore, different types of dairy consumed or restricted should be considered in future studies, to assess whether this impacts the effect on psoriasis and to increase understanding of potential mechanisms of action. Understanding whether PLwP should restrict any dairy, or only certain types, could limit the unnecessary restriction of dairy and risk of subsequent micronutrient deficiencies and health impacts. Further exploration of the impact of dairy on psoriasis and micronutrient intake would provide important evidence for PLwP and HCPs to help combat misinformation and enhance the ability of HCPs to provide appropriate support Interestingly, the findings of this research also highlight that the impact of dairy restriction on psoriasis is variable. Understanding whether this is due to the types of dairy being restricted, the amount of dairy being replaced, the dietary component used to replace dairy, or other factors, is a key knowledge gap in the field.

The findings of this thesis indicate that restricting high-sugar foods is perceived by PLwP to be an effective dietary modification to improve psoriasis (Chapter 4). Emerging evidence also suggests that sugar is perceived to be a "trigger" for psoriasis flare-ups (7). However, no research has investigated this further. Further exploration into the impact of sugar on psoriasis through RCTs or dietary intake studies without reliance on self-reporting psoriasis impact, would be beneficial. Moreover, understanding the potential mechanism underlying the impact of sugar on psoriasis could provide valuable insights into effective dietary management approaches.

Given the findings of this thesis, which reveal the prevalence of unsubstantiated dietary changes among PLwP, it is essential to engage in discussions about the potential nutritional benefits and risks of dietary changes. This is particularly important considering the findings of the questionnaire revealed that the primary reason for PLwP turning to diet to try and help their psoriasis was the desire to also try and improve general health (Chapter 4). This highlights a key opportunity for HCPs to promote healthy eating among this population, even if specific dietary recommendations for psoriasis are not available. Considering the health conditions associated with psoriasis, integrating dietary support in psoriasis care

could play a key role in providing comprehensive care and preventing the progression of psoriasis-related co-morbidities.

Furthermore, if improving health is the primary motivation for implementing dietary modifications to manage psoriasis, the predominance of restrictive dietary changes made without the guidance of a healthcare professional (HCP) reveals a significant disconnect. The findings from the qualitative study suggest that the pursuit of information often overshadows concerns about the potential risks associated with restrictive diets (Chapter 3). The dietary practices of PLwP, identified in this thesis, may lead to the opposite of improvement in overall health, through the restriction or complete elimination of certain food groups or reducing the intake of important micronutrients (17–19). Furthermore, PLwP perceive there to be a lack of dietary support from HCPs, and often feel dismissed regarding dietary interventions, resulting in diet not being discussed at all. HCPs involved in psoriasis care often feel unable to provide adequate dietary support that psoriasis patients ask for (23). Despite the current limited evidence on the relationship between diet and psoriasis, it is evident that people living with psoriasis (PLwP) are experimenting with restrictive diets. Therefore, it is crucial to acknowledge this trend and provide appropriate support. Restrictive diets, if not managed properly, can lead to micronutrient deficiencies (MNDs) (17–19), highlighting a need to explore nutritional status and dietary intake of PLwP. Emerging research indicates that systemic inflammation is seen in undernourished individuals, serum concentrations of IL-6 are significantly higher in undernourished patients compared with healthy controls (20). More research is needed to fully understand the impact of undernutrition or specific MNDs on inflammation. However, IL-6 is an inflammatory cytokine that is increased in PLwP (21,22). This underscores the need to provide dietary support to this population as the self-prescribed diets to help psoriasis may have undesirable and counterproductive impacts.

A reoccurring finding of this thesis was the confusion among participants regarding the type and extent of dietary change needed to manage psoriasis symptoms. Participants reported feeling overwhelmed by the number of dietary recommendations, ranging from extreme exclusion diets to vague, dietary additions. These suggestions often provided insufficient

explanation and a lack of information on the evidence supporting said diets and populations that these applied to. For instance, while certain evidence-based recommendations such as weight loss or gluten-free diets may be beneficial in specific subgroups of PLwP (7), it is reported that these were often presented as universally applicable, with little information on who they were intended for or how they should be followed (Chapter 3).

Currently, there is limited high-quality evidence on the type of dietary modification required to achieve improvements in psoriasis (2). The findings of this thesis suggest that participants perceived different dietary changes to have varying effects on their psoriasis, reflecting existing literature, which indicates that PLwP may respond differently to dietary interventions (2,7). The extent of dietary change required to ameliorate psoriasis may also vary depending on an individual's current health and nutritional status, dietary intake, disease severity, and comorbidities. These findings highlight the need for clear, accessible, dietary support that helps PLwP understand what dietary changes might be relevant for them. However, further research is needed to clarify these relationships. Dietary recommendations should provide appropriate guidance to ensure they are nutritionally adequate and interpreted correctly.

It is well recognised issue that HCPs often receive insufficient nutritional training (24), which may limit their ability to provide such support. This highlights the need for further investigation into strategies to address this. The findings of this thesis offer insights into the dietary practices of PLwP that could help HCPs provide more tailored dietary support. Ensuring that HCPs are aware of the unsubstantiated dietary moderations that are popular among PLwP, identified in this thesis, and the potential harms of these, could enable HCPs to provide more practical dietary support. This approach could help bridge the gap between patient needs and the current limitations in evidence-based dietary management. In order to fully understand how to provide this support it is essential to explore the perspectives of HCPs involved in psoriasis care. Principally, their experiences and perceived ability to provide such support, alongside their interest and desire for further education and resources to enable them to offer this vital support. Additionally, engaging healthcare

professionals who work with patients from diverse cultural, ethnic and socioeconomic backgrounds, as well as those who support patients with various comorbidities is crucial to obtain a comprehensive understanding of patient needs (26,27). Increasing inclusive engagement will help inform the design of tailored dietary resources that are both culturally appropriate and practically applicable across different settings (26-29), ultimately increasing their impact and relevance. Furthermore, exploring the role and potential benefits of involving registered nutritionists and dietitians in psoriasis care could provide a key interdisciplinary approach and improve patient outcomes.

The findings of this thesis suggests that dietary recommendations followed by PLwP may originate from social media or online forums within psoriasis communities. This aligns with findings from a study in the US (7) and it is also seen in other conditions (25). Understanding the role of social media misinformation in influencing dietary practices of PLwP and the potential health impacts is a key area for future research. Exploring this could enable the development of strategies to effectively combat dietary misinformation with evidence-based advice and equip HCPs to support PLwP to make healthy dietary choices, identify misinformation and improve health outcomes.

A unique contribution of this thesis is the development of a dietary support guide to address the identified dietary support gaps for PLwP. The guide was informed by the insights gained from the qualitative (Chapter 3) and quantitative studies (Chapter 4), and created using a UCD approach (Chapter 5), incorporating feedback from both PLwP and HCPs to ensure its usability and relevance in real-world settings. This resulted in a guide which was perceived to have good usability and was useful and valuable to intended users. However, exploring needs in a more diverse patient population and incorporating PPIE alongside understanding the needs and desire of nutritional training among HCPs may further highlight considerations for dietary support and guideline updates. This is crucial given the significant comorbidities associated with psoriasis. This approach could ensure that policy and practice are better aligned with the comprehensive needs of individuals with psoriasis and patient-centred care.

To ensure future dietary support is inclusive and usable by a wider population of people in the UK with psoriasis, it is essential to explore the needs of a more diverse population living with psoriasis. This includes not only increasing male representation, but also people from a range of cultural, socioeconomic and ethnic backgrounds, each of whom may follow different dietary patterns, have different experiences with HCPs, and encounter unique barriers to accessing or interpreting dietary advice (26, 27). Regarding the focus and participant population of this thesis, it is important to acknowledge that perceptions, dietary beliefs and practices, and sources of dietary information may differ from those reflected in the current findings. These have informed the research studies and development of the dietary guide. It is not appropriate to assume that all PLwP have the same experiences. For example, culturally specific diets, language barriers, and varying levels of trust or interaction with healthcare professionals can influence how health information is received and acted upon (28,29). These factors have been shown to vary across different ethnic and cultural groups and may therefore impact the usability and applicability of the dietary guide. Additionally, future work must consider further accessibility needs, such as individuals with hearing, visual, cognitive, or literacy challenges, as well as non-English speakers, for whom dietary information and support must be accessible, translated, culturally adapted, and clearly communicated (26,27). Access to information alone is insufficient to improve health outcomes; it must also be accurately understood and practically applied. This highlights the importance of future research that includes and reflects the needs and input of diverse populations in the development of dietary resources for PLwP in the UK (26,27,28).

Furthermore, even though HCPs were involved in the process of developing this guide, it would be useful to investigate the perceived usability with a wider representation of HCPs involved in psoriasis care, to evaluate the guide's real-world application in clinical practice. Future research should focus on how HCPs use and perceive the guide, including their interpretations, feedback and perceived value and usability to further refine and optimise dietary support strategies for PLwP. Furthermore, understanding the impact of the guide on dietary decisions made by PLwP would also be a beneficial area of future research.

The findings highlight a critical gap in current psoriasis care that warrants attention and underscores an urgent consideration for policy and guideline development for dietary support in psoriasis management. The findings of this thesis could be used as a basis to inform existing care guidelines for psoriasis to address this care gap. Exploration into incorporating pathways that include referrals to dietitians for patients interested in dietary modifications could beneficial.

Finally, the findings of this thesis could provide a foundation for exploration of tailored solutions to address dietary support gaps in other conditions. Particularly in those where dietary modifications are common and the evidence for dietary management strategies may still be emerging, hence limiting the ability for HCPs to provide this type of support in clinical practice. Providing guidance, based on real-world experiences and needs, in the interim of more robust evidence being generated is vital, and could have beneficial impacts on patient outcomes across various conditions.

6.3 LIMITATIONS

A key limitation of the research is that most participants were white and female, which may impact the generalisability of the findings. Research shows that women may be more likely to look for health information and follow certain health-related behaviours including dietary changes, compared to men (30,31). Furthermore, white females may engage differently with health behaviours and have different dietary preferences compared to other ethnic or gender groups. Research has shown that white females, particularly those with higher education levels, may have better nutrition knowledge and be more likely to look for this information (32). Therefore, studies with predominately white female participants may overestimate frequency of such behaviours in a population. As discussed above, it is therefore key to explore this in a more diverse and representative sample to enhance the accessibility and relevance of the findings to the wider population of PLwP. This includes incorporating the perspectives and experiences of underrepresented groups in this thesis such as, men, non-white populations, those with low health literacy, and those who may be less engaged in diet or self-management practices. Research suggests that lower health literacy is associated with unhealthy dietary patterns (33,34). Insight into socioeconomic

factors could have also improved the understanding of this topic, as this can impact diet and access to health information and care (35,36). Understanding the unique support needs or challenges of these groups would help the findings to be more inclusive. It is also important to explore how to increase inclusion of PLwP from different backgrounds in health research, to provide more comprehensive insights. Improving access to PPIE roles for more diverse groups in health research has been suggested as a way of improving this (37,38) and would be an important consideration in future studies with PLwP. Moreover, building on the insights gained from the perspectives of PLwP, it is equally important to understand the viewpoints of HCPs regarding the role of diet in psoriasis management. While this thesis has primarily focused on the experiences and needs of PLwP, exploring the perspectives of HCPs could provide a more comprehensive understanding of the current landscape of dietary support in psoriasis care. Despite this, the research undertaken in this thesis has provided novel insights into the dietary practices, lived experiences, and support needs of PLwP in the UK, which has not been explored before. It has also identified important gaps in the existing literature and highlighted key areas for future research, particularly the need for more inclusive studies that involve underrepresented groups.

6.4 CONCLUSION

Through a mixed-methods approach this thesis has provided novel and context-specific understanding of the dietary practices, experiences, and needs of PLwP in the UK. Each stage of the research was informed by previous findings, creating a cohesive understanding that allowed for a unique and in-depth exploration of the role of diet in the management of psoriasis. The findings contribute to the field of diet and psoriasis and provide a solution to the absence of context-specific and evidence-based dietary support.

This thesis uncovered a clear demand for dietary guidance among PLwP, who frequently experiment with unsubstantiated dietary modifications. These are often not evidence based and are frequently followed without guidance from a HCP. A novel and interesting finding of this research was that dairy restriction was the most trialled dietary modification, despite an absence of studies investigating its impact on psoriasis. These findings highlight the critical need for more targeted research, such as randomised controlled trials (RCTs), to

better understand the effects of specific dietary interventions on psoriasis outcomes and elucidating potential mechanism of action. Moreover, this thesis highlighted the importance of considering comorbid conditions associated with psoriasis, as dietary patterns like the MD could offer broader health benefits beyond psoriasis management.

The findings highlight the importance of integrating nutrition support into patient care across a range of other conditions. This approach is particularly important in cases where there is limited evidence or no established dietary guidelines, and where comorbidities play a significant role in patient outcomes. Understanding patient needs and integrating context-specific nutritional support may enhance the ability of HCPs to meet the diverse needs of patients.

Future research should continue to build on these insights by conducting larger observational and RCTs on dairy restriction and anti-inflammatory dietary patterns, most notably the MD, explore the perspectives of underrepresented populations and HCPs further, and assess the impact of the dietary support guide in clinical practice, to optimise dietary management and support strategies for psoriasis.

6.5 RECOMMENDATIONS FOR AREAS FOR FUTURE RESEARCH

- There is an urgent need for more extensive RCTs and longitudinal studies to explore the impact of diet, beyond low-calorie diets for weight loss and gluten-free interventions in individuals with coeliac disease, on psoriasis.

- While the Mediterranean diet shows potential in reducing psoriasis severity, this is currently only supported by observational studies. Therefore, longitudinal studies investigating the adherence to the MD and the onset and severity of psoriasis are warranted. Additionally, RCTs investigating the impact of the MD on psoriasis severity would

provide more robust evidence regarding the impact of diet on psoriasis, which could help inform comprehensively beneficial dietary recommendations.

- Further research to explore the impact of anti-inflammatory dietary patterns that provide health benefits relating to the comorbidities, other than the MD, would be beneficial. The DASH diet may be a promising option, and observational studies could serve as an initial study in understanding its impact on psoriasis.

- Dairy restriction is frequently trialled among PLwP. Dairy is a diverse food group and can provide an important source of micronutrients. If it is being unnecessarily restricted or promoted as a dietary management tool for psoriasis it may mean people reduce their micronutrient intake unnecessarily. Therefore, this area requires detailed investigation through observational studies and RCTs to assess the impact of dairy on psoriasis, with a focus on the type of dairy consumed and potential mechanisms of action.

- Assessing the dietary intake of PLwP and the potential consequences of following restrictive diets without supervision, would be valuable for understanding the nutritional status, risk of micronutrient deficiencies, and health impacts.

- Given the limited evidence on the impact of sugar on psoriasis, more robust studies are needed to establish a clear understanding surrounding the impact and any potential mechanisms of this dietary component on psoriasis.

- Future research should build on the insights generated by this thesis, by exploring the perspectives and experiences of underrepresented groups of PLwP in the UK. This will help address the highlighted research gap and ensure that the dietary support needs, and the development of dietary support resources, are relevant and usable for a more diverse population of PLwP in the UK.

- Future research should explore the potential value of the dietary support guide developed in this thesis, with HCPs. Given that many HCPs report feeling inadequately equipped to provide dietary support to PLwP, exploring their perspectives on the real-world application of the guide in clinical practice would be useful. Furthermore, it would be

beneficial to include a more diverse population in future studies to ensure that the guide is relevant and effective across different demographic groups.

- Exploring the use of the guide in clinical practice and measuring its impact on patient outcomes and dietary decisions of PLwP would provide beneficial insight into its usability and effectiveness in a real word setting. This may also provide insights that could be used to further refine the guide.

- Further investigation into strategies for better supporting HCPs in delivering effective dietary support for PLwP would be beneficial. The exploration of how nutrition professionals could be integrated into psoriasis care and the impact of this on patient outcomes would be beneficial. This might offer solutions to close gaps in care and enhance patient outcomes and could provide insight into strategies to optimise interdisciplinary approaches for better patient care and potentially reduce the burden of the associated co-morbidities.

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7. APPENDIX

7.1 Chapter 3 Appendix 1: Consolidated criteria for reporting qualitative studies (COREQ): 32-item checklist

Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Health Care. 2007. Volume 19, Number 6: pp. 349 – 357

No. Item	Guide questions/description	Reported on Page #
Domain 1: Research team and reflexivity		
Personal Characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	5
2. Credentials	What were the researcher's credentials? E.g. PhD, MD	5,6
3. Occupation	What was their occupation at the time of the study?	5,6
4. Gender	Was the researcher male or female?	5,6
5. Experience and training	What experience or training did the researcher have?	5,6
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	5
7. Participant knowledge of the interviewer	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	5
8. Interviewer characteristics	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	5,6
Domain 2: study design		
Theoretical framework		
9. Methodological orientation and Theory	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	6
Participant selection		

10. Sampling	How were participants selected? e.g. purposive, convenience, consecutive, snowball	5

11. Method of approach	How were participants approached? e.g. faceto-face, telephone, mail, email	5
12. Sample size	How many participants were in the study?	6,7
13. Non-participation	How many people refused to participate or dropped out? Reasons?	N/A
Setting		
14. Setting of data collection	Where was the data collected? e.g. home, clinic, workplace	6
15. Presence of nonparticipants	Was anyone else present besides the participants and researchers?	6
16. Description of sample	What are the important characteristics of the sample? e.g. demographic data, date	6,7
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	5
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	5,6
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	5,6
20. Field notes	Were field notes made during and/or after the interview or focus group?	N/A
21. Duration	What was the duration of the interviews or focus group?	6
22. Data saturation	Was data saturation discussed?	N/A
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	N/A
Domain 3: analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	6
25. Description of the coding tree	Did authors provide a description of the coding tree?	N/A
26. Derivation of themes	Were themes identified in advance or derived from the data?	6
27. Software	What software, if applicable, was used to manage the data?	6
28. Participant checking	Did participants provide feedback on the findings?	5,6

Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	8-17
30. Data and findings consistent	Was there consistency between the data presented and the findings?	8-17
31. Clarity of major themes	Were major themes clearly presented in the findings?	7-17
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	7-17

7.2 Chapter 3 Appendix 2: Topic Guide for Individual Interviews

Nutrition in psoriasis study: exploring perceptions and experiences of the role of nutrition in the progression and management of psoriasis

INTRODUCTION

Thank you for agreeing to take part in our study on perceptions and experiences of nutrition in the progression and management of psoriasis. The study aims to explore to what extent individuals with psoriasis perceive that diet is important and/or plays a role in the development/progression and management of their condition.

We will ask some general health background questions first then specific questions about your perceptions and experience of the impact of nutrition in the progression (e.g., flares) and management of your plaque psoriasis. The interview will last around 45 minutes or longer, but it depends how much you have to say. If we ask something that's not relevant just let us know and we will move on. We are really interested in your experiences so feel free to give us as much detail as you'd like to. When we analyse all the interviews, we will write up the findings without referring to your name or anything that identifies others in your household or family.

So that we can accurately type up what you say today I'd like to audio record the interview. The recording will be deleted once the transcript has been written up. Is that OK with you?

Do you have any questions before we start?

PART A: HEALTH BACKGROUND [refer to Online Survey details to summarise/check/ elaborate here]

- Age of participant
- Do you have psoriasis?
    - If yes, what type, & how severe?
        - Use PASI Index [APPENDIX E]
- How long have you had psoriasis/ when were you diagnosed?
- Did anything trigger your initial symptoms/diagnosis? (i.e., Infection/illness?)
- Have you noticed any pattern in your symptoms?

PART B: ROLE OF DIET IN MANAGING PSORIASIS

1. What factors do you think contribute most to your **flare ups and/or condition (i.e., development)**?

a. Does stress impact your condition?
    i. How would you describe your stress levels?
b. Does what you eat and/or drink impact your condition?
    i. Have you ever suffered from pain/wind/bloating?
    ii. How frequent are your bowel movements?
    iii. Are your bowel movements often soft and/or hard and difficult to pass?
c. Do you think family history and/or genetics impacts your condition?
d. Does Illness or infection, including testing positive for Covid-19, impact your condition?
e. Do you think weight impacts your psoriasis?
f. Do other conditions and/or co-morbidities impact your condition?

2. What factors do you think play a role in **managing a flare up and/or your condition**?
    a. *(As above for probing about known factors – including medication)*

3. Have you identified any dietary triggers related to your condition?
    a. What are these?
    b. How did you identify these? (e.g., using a symptoms diary)
    c. Did you and/or are you still changing your diet are a result of this?

4. Have you ever **excluded** anything from your diet?
    a. What did you exclude?
    b. Was this helpful/ beneficial and in what way?
    c. CHECK if related to another condition
    d. Did you and/or are you still changing your diet are a result of this?

5. Have **you ever added** anything to your diet?
    a. What did you exclude?
    b. Was this helpful/ beneficial and in what way?
    c. CHECK if related to another condition
    d. Did you and/or are you still changing your diet are a result of this?

6. Have you received any dietary advice in relation to managing your psoriasis?
    a. From whom?
    b. Did you follow it?
    c. How useful was it?
    d. Which lifestyle/dietary factors were targeted by the person who gave you advice? [If mentioned prompt for weight re: weight stigma]

7. Would you consider making changes to your diet in the future?
    a. If not tried previously, what are the barriers that have prevented you from making dietary changes? (E.g., lack of evidence, cooking skills, motivation etc.)

8. What support would be useful to help you make changes to your diet? (If perceived as useful/beneficial)

9. Are you aware of anyone that has successfully managed their psoriasis with diet?

PART C: CURRENT DIETARY HABITS

10. How would you describe your diet? (Healthy/unhealthy? Vegetarian? Cooked/convenience? Restrictive? Varied? Ketogenic? Carnivorous?)

11. Do you drink alcohol? (If so, what pattern? How many units? What type?)

PART C: PERCEPTIONS OF RECEIVING NUTRITION ADVICE

12. Are you a member of any patient support groups? If so, which do you find most helpful & for what reasons?

13. Re: diet, do you think it would be beneficial to have access to a dietitian and/or nutritionist as part of your management? (I.e., freely available on the NHS).

THAT'S THE END OF THE INTERVIEW, thank you for your time. Is there anything else you'd like to tell me or add?

7.3 Chapter 4 Appendix 1: The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE)Statement

STROBE Statement—checklist of items that should be included in reports of observational studies. *Von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies*.

	Item No.	**Recommendation**	**Page No.**
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	7-9

		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	N/A

Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-10
Bias	9	Describe any efforts to address potential sources of bias	7-8
Study size	10	Explain how the study size was arrived at	7-9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7-8
		(*c*) Explain how missing data were addressed	7-8
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	7-8
		(*e*) Describe any sensitivity analyses	7-8
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9-16
		(b) Give reasons for non-participation at each stage	N/A
		(c) Consider use of a flow diagram	9
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-16

		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	N/A
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	N/A
		Cross-sectional study—Report numbers of outcome events or summary measures	*9-16*
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-16
		(*b*) Report category boundaries when continuous variables were categorized	N/A
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-16
Discussion			
Key results	18	Summarise key results with reference to study objectives	18

Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	21-22
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	18-22
Generalisability	21	Discuss the generalisability (external validity) of the study results	18-22
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding section

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

7.4 Chapter 5 Appendix 1: Guidance for Reporting Involvement of Patients and the Public long form (GRIPP2-LF)

Section and topic	Item	Reported on page No
Section 1: Abstract of paper		
1a: Aim	Report the aim of the study	1
1b: Methods	Describe the methods used by which patients and the public were involved	1
1c: Results	Report the impacts and outcomes of PPIE in the study	1
1d: Conclusions	Summarise the main conclusions of the study	1
1e: Keywords	Include PPIE, "patient and public involvement," or alternative terms as keywords	1
Section 2: Background to paper		
2a: Definition	Report the definition of PPIE used in the study and how it links to comparable studies	2-3
2b: Theoretical underpinnings	Report the theoretical rationale and any theoretical influences relating to PPIE in the study	2-3
2c: Concepts and theory development	Report any conceptual models or influences used in the study	2-3
Section 3: Aims of paper		
3: Aim	Report the aim of the study	2
Section 4: Methods of paper		
4a: Design	Provide a clear description of methods by which patients and the public were involved	3
4b: People involved	Provide a description of patients, carers, and the public involved with the PPIE activity in the study	3-5
4c: Stages of involvement	Report on how PPIE is used at different stages of the study	3-8
4d: Level or nature of involvement	Report the level or nature of PPIE used at various stages of the study	3-8
Section 5: Capture or measurement of PPIE impact		

5a: Qualitative evidence of impact	If applicable, report the methods used to qualitatively explore the impact of PPIE in the study	10

5b: Quantitative evidence of impact	If applicable, report the methods used to quantitatively measure or assess the impact of PPIE	15
5c: Robustness of measure	If applicable, report the rigour of the method used to capture or measure the impact of PPIE	13
Section 6: Economic assessment		
6: Economic assessment	If applicable, report the method used for an economic assessment of PPIE	n/a
Section 7: Study results		
7a: Outcomes of PPIE	Report the results of PPIE in the study, including both positive and negative outcomes	17
7b: Impacts of PPIE	Report the positive and negative impacts that PPIE has had on the research, the individuals involved (including patients and researchers), and wider impacts	17
7c: Context of PPIE	Report the influence of any contextual factors that enabled or hindered the process or impact of PPIE	16
7d: Process of PPIE	Report the influence of any process factors, that enabled or hindered the impact of PPIE	17
7ei: Theory development	Report any conceptual or theoretical development in PPIE that have emerged	n/a
7eii: Theory development	Report evaluation of theoretical models, if any	17
7f: Measurement	If applicable, report all aspects of instrument development and testing (eg, validity, reliability, feasibility, acceptability, responsiveness, interpretability, appropriateness, precision)	17
7g: Economic assessment	Report any information on the costs or benefit of PPIE	n/a
Section 8: Discussion and conclusions		

8a: Outcomes	Comment on how PPIE influenced the study overall. Describe positive and negative effects	18
8b: Impacts	Comment on the different impacts of PPIE identified in this study and how they contribute to new knowledge	18
8c: Definition	Comment on the definition of PPIE used (reported in the Background section) and whether or not you would suggest any changes	18
8d: Theoretical underpinnings	Comment on any way your study adds to the theoretical development of PPIE	18
8e: Context	Comment on how context factors influenced PPIE in the study	19
8f: Process	Comment on how process factors influenced PPIE in the study	19
8g: Measurement and capture of PPIE impact	If applicable, comment on how well PPIE impact was evaluated or measured in the study	n/a
8h: Economic assessment	If applicable, discuss any aspects of the economic cost or benefit of PPIE, particularly any suggestions for future economic modelling.	n/a
8i: Reflections/critical perspective	Comment critically on the study, reflecting on the things that went well and those that did not, so that others can learn from this study	15-19

7.5 Chapter 5 Appendix 2 Dietary Scenario for Phase 3: Think Aloud

Dietary Scenario 1

Changing my diet really worked for me!

I recommend following a dairy-free diet and cutting out gluten to help your psoriasis. I also suggest cutting out meat. This diet has worked for me and other people with psoriasis. I also recommend cutting down on your alcohol too.

Dietary Scenario 2

Following a Mediterranean style diet can cure your psoriasis.

If you're searching for a diet to cure your psoriasis, then a Mediterranean diet may be the answer. This diet is celebrated for its many health benefits. The Mediterranean diet involves eating plenty of whole grains, fruits and vegetables and healthy fats. These components are rich in vitamins, minerals, and antioxidants that may help reduce inflammation and cure your psoriasis.

7.6 Chapter 5 Appendix 3: Phase 3: Think Aloud Topic Guide

Welcome the participant and ask if there are any questions regarding the participant information sheet or about the study. Confirm informed consent.
If consent is obtained, let the participant know you will now start the study.

[Explain think aloud to the participant]
In this study, we are interested in understanding how you interpret and what you think about as you use this tool when looking at two typical dietary suggestions. To help us to understand how people might use the tool and any ways we could improve it. In order to do this, I am going to ask you to think aloud as you look over each dietary scenario whilst using the tool.

When I say "think aloud" I mean that I want you to tell me everything you are thinking from the first time you see the tool until you have completed the dietary tasks. This may take a while to get used to. Just act as if you were alone, speaking to yourself. It is important that you keep talking. If you are silent for any long period of time, I will prompt you to "remember to think aloud" or ask you to "talk through your thoughts". This is not a test; it is a way to help us to understand how people use the tool as it currently is.

Do you understand what you are being asked to do? Do you have any questions?

[Think aloud warmup activity]
As a warmup and to help you get used to thinking aloud, I will ask you to start by explaining a simple task to me.

Please explain in detail each step that you take when preparing your favourite drink. Thank them, and let them know that if they are ready, we will know start the study using the tool.

Let the participant know you will know start the recording. Start the recording [Show the participant the tool and then the first dietary scenario, followed by the second dietary scenario]

If needed prompt *"remember to think aloud"* or "*talk through your thoughts"*.

Once finished, thank the participant and let them know that you will know ask them some questions about their experience using the tool.
[Use the Post Think Aloud interview guide]

Post Think Aloud interview guide

1. What did you think of the tool?

2. Were there any parts of the scenario's that you found difficult to navigate using the tool? *If yes, what specifically were these? Could you expand on this?*

3. Were there any areas that you would have liked more guidance or information on?

If yes, what specifically were these? Could you expand on this?

4. Do you think you would use this tool if you saw a dietary recommendation for psoriasis?

If no, why do you say that? Could you expand on this?

5. What in particular did you like or dislike about the tool?

If dislike, *could you expand on this?/ how do you think this could be improved? If like, could you expand on why you liked this?*

6. What in particular did you find useful about the tool?

Could you expand on why you found this useful?

7. Did you find any of the information provided, or the way the tool is designed confusing?

If yes, could you expand on this?/ how do you think this could be improved?

8. How do you think the tool could be improved?

9. Have you seen any dietary recommendations for psoriasis that you would not be able to apply this tool to?

If yes, could you expand on this?/ how do you think this tool could be improved to include guidance for other recommendations?

10. Do you have any other comments about the tool?

7.6 Chapter 5 Appendix 4: The 10-item System Usability Scale (SUS) and value questions

The 10-item System Usability Scale (SUS)

1. **I think that I would like to use this guide frequently**

Strongly Disagree Strongly Agree

1	2	3	4	5

2. **I found the guide unnecessarily complex***

Strongly Disagree Strongly Agree

1	2	3	4	5

3. **I thought the guide was easy to use**

Strongly Disagree Strongly Agree

1	2	3	4	5

4. **I think that I would need the support of a technical person to be able to use this guide***

Strongly Disagree Strongly Agree

1	2	3	4	5

5. **I found the various sections this guide to be well-integrated**

Strongly Disagree Strongly Agree

1	2	3	4	5

6. **I thought there was too much inconsistency in this guide***

Strongly Disagree Strongly Agree

1	2	3	4	5

7. **I would imagine that most people would learn to use this guide very quickly**

Strongly Disagree Strongly Agree

1	2	3	4	5

8. **I found the guide very awkward to use***

Strongly Disagree Strongly Agree

1	2	3	4	5

9. **I felt very confident using the guide**

Strongly Disagree Strongly Agree

1	2	3	4	5

10. **I needed to learn a lot of things before I could get going with this guide***

Strongly Disagree Strongly Agree

1 2 3 4 5

*negatively scored items

Perceived value of the tool questions

Q1. We want to understand how useful you think this tool is in helping you to navigate nutrition and dietary information to make decisions to manage your psoriasis symptoms.
To what extent do you agree with the following statement:
"I found this tool useful to help me make decisions about diet and psoriasis."

Strongly Disagree Strongly Agree

1 2 3 4 5

Q2. We want to understand how valuable you think this tool is in terms of helping people living with psoriasis to make informed decisions about nutrition and their diet to manage psoriasis symptoms.
To what extent do you agree with the following statement:
"This is a valuable tool to help people make informed decisions about nutrition and diet to manage their psoriasis symptoms."

Strongly Disagree Strongly Agree

1 2 3 4 5

7.7 Chapter 5 Appendix 5: Final Guide

A Guide to Nutrition Information for Psoriasis

University of Hertfordshire UH

Made by nutrition and dermatology experts, and people living with psoriasis. Use this guide to help you make sense of information on diet and psoriasis.

Diets

Many diets claim to help psoriasis, but **not all are supported by science**. Some diets might be too strict and could be harmful. **Information on diet and psoriasis, and tips on what to be careful of is set out below.**

Low-calorie diet for weight-loss

What does it require? Eating less to lose weight.

What does the research say? Studies show that losing weight can help psoriasis. **But only in people who are obese or overweight**. In people who are obese or overweight weight-loss can also improve overall health. It **lowers the risk of heart disease, type 2 diabetes and other health conditions.**

Things to be aware of: Eating healthily is important, even if you're cutting calories. Watch out for super strict or quick weight loss plans. They might not be safe or work long-term. **If you're already a healthy weight, you don't need to follow a low-calorie diet or lose weight.**

If you need help losing weight safely, talk to your GP or visit the link below for more information:

https://www.nhs.uk/live-well/healthy-weight/managing-your-weight/tips-to-help-you-lose-weight/

Gluten Free Diet

What does it require? Not eating anything that has gluten in it. Gluten is a protein found in wheat, barley and rye.

What does the research say? Some studies show that not eating gluten can help psoriasis. **But only in people who have coeliac disease or a gluten sensitivity**. Coeliac disease is when the body reacts badly to gluten and harms the gut. In people with a gluten sensitivity, gluten can cause bloating and discomfort. **A gluten-free diet does not seem to help psoriasis in people without these conditions.**

Things to be aware of: A gluten-free diet is only healthier if you have coeliac disease. **Gluten-free diets can have less fibre**. Fibre is important for health. If you cut out gluten, make sure you know which foods contain it and **eat enough fibre**. For tips on following a healthy gluten-free diet, visit the link below:

https://www.coeliac.org.uk/information-and-support/living-gluten-free/the-gluten-free-diet/

Mediterranean Diet

What does it require? Eating a healthy balanced diet. Which is high in fruits and vegetables, legumes, wholegrains, fish and olive oil, and low in sugar, meat, dairy and alcohol.

What does the research say? Studies suggest that **eating a Mediterranean diet might help psoriasis.** But we need more studies to know if there is a definite link.

Things to be aware of: For most a Mediterranean diet is safe and healthy. Many studies show that **it is good for you.** It reduces the risk of type 2 diabetes, obesity, and high blood pressure. **For more information visit this link:**

https://www.bhf.org.uk/informationsupport/heart-matters-magazine/nutrition/mediterranean-diet/

Dairy Free Diet

What does it require? Removing all dairy from your diet. Dairy is any product made from or using cow's milk (e.g., milk, cheese, butter, yoghurt etc.).

What does the research say? No studies have been done on dairy and psoriasis. In people who stopped eating dairy, some said that it made their psoriasis better, but others did not see any change.

Things to be aware of: Dairy is an important **source of protein, vitamin B12 and B2, calcium and iodine.** It can form part of a healthy diet. **If you stop eating dairy, you need to get these nutrients from other foods.** Choose dairy-free foods with these nutrients in, or take supplements. **For more information visit the link below:**

https://www.nhs.uk/live-well/eat-well/food-types/milk-and-dairy-nutrition/

Vegetarian Diet

What does it require? Not eating any meat or fish, or any foods that contain them.

What does the research say? No studies have looked at vegetarian diets and psoriasis. Some people who tried a vegetarian diet said it helped their psoriasis, but others didn't see any change.

Things to be aware of: Meat and fish have a lot of important nutrients that our bodies need. **They are good sources of protein, iron and vitamin B12.** Oily fish (e.g., mackerel, sardines and salmon) are important sources of healthy fats, like omega-3. If you follow a vegetarian diet make sure you eat foods that have these nutrients in or take supplements. **For information on how to eat a healthy vegetarian diet, follow the links below:**

https://www.nhs.uk/live-well/eat-well/how-to-eat-a-balanced-diet/the-vegetarian-diet/

Vegan Diet

What does it require? Not eating any foods that come from animals. This includes meat, dairy and eggs, and any foods that contain them.

What does the research say? No studies have looked at vegan diets and psoriasis. Some people who have tried a vegan diet said it helped their psoriasis, but others didn't see any change. No information was given on what these people ate as part of their vegan diet.

Things to be aware of: Animal foods have lots of good stuff that our bodies need. If you go vegan, you might not get enough **calcium, iron, vitamin B12, iodine, and selenium**. Make sure you eat foods that have these nutrients in them or take supplements. **For information on how to eat a vegan diet safely, visit the link below:**

https://www.nhs.uk/live-well/eat-well/how-to-eat-a-balanced-diet/the-vegan-diet/

Other nutrition terms

ANTI-INFLAMMATORY

The **term anti-inflammatory may be used to try and get your attention.** It is not a set diet, but what you eat can impact inflammation and your immune system.

Some diets have anti-inflammatory qualities. These are usually high in fruits and vegetables, fibre, and healthy fats, and low in sugar, unhealthy fats, and alcohol. The Mediterranean diet has anti-inflammatory qualities. **A great way to support your immune system is by eating a balanced diet, with lots of nutrients.**

PLANT BASED

A plant-based diet means eating mostly foods from plants. Such as vegetables, fruits, grains, nuts, and beans. Eating more fruit and vegetables may help psoriasis. **It is important that your diet is still balanced and healthy**. For information on a healthy plant-based diet, follow the link:

https://www.bda.uk.com/resource/vegetarian-vegan-plant-based-diet.html

Cutting-out

Some people believe that cutting-out certain foods can help psoriasis.

Alcohol

Alcohol can make psoriasis worse. Studies show that drinking less or no alcohol might help psoriasis. **For tips on cutting down follow the link below:**

https://www.nhs.uk/live-well/alcohol-advice/tips-on-cutting-down-alcohol/

Sugar

Some people find eating less sugar helps psoriasis, but more studies are needed. Too much sugar is not good for you. **For tips on cutting down follow the link below:**

https://www.nhs.uk/live-well/eat-well/how-to-eat-a-balanced-diet/how-to-cut-down-on-sugar-in-your-diet/

Red Meat

Some find eating less red meat helps psoriasis, but more studies are needed. Eating some **red meat can help you get enough iron** in your diet. This is important for women of child-bearing age, but too much can be bad for health.

Nightshades

Nightshades are a group of plants that include tomatoes, potatoes, aubergines, and peppers. Some find that not eating nightshades helps psoriasis, others do not. More studies are needed. **Nightshades are also full of nutrients.**

HELPFUL TIPS

Keep a food and symptom diary whilst you are making changes to what you eat. This will help you to see what has helped or what has not made a difference.

If certain foods or drinks seem to worsen your psoriasis, **try cutting them out one by one**. Avoid each item for 2-6 weeks. Then try eating them again and see if your psoriasis worsens. Record this to keep track.

For more information on food allergies see advice from the British Dietetic Association (BDA) here: **https://www.bda.uk.com/resource/food-allergy-intolerance.html**

Seek advice from a nutrition professional if you cut out food groups from your diet.

Adding-in

Some people believe that adding or eating more of certain foods can help psoriasis.

Fruit and Vegetables

Fish

Fibre

Some people find that **eating more fruit and vegetables helps their psoriasis. This is the same for fish. Eating more fibre may be linked to less severe psoriasis.** More studies are needed, but these are key parts of a healthy balanced diet. As well as drinking enough water.

HELPFUL TIPS

If you decide to cut out or add something to your diet, **make sure you are still eating healthily**. For information on eating a healthy balanced diet, visit the link below:

https://www.nhs.uk/live-well/eat-well/how-to-eat-a-balanced-diet/eating-a-balanced-diet/

Follow this link for ideas to help you to eat well and keep costs down:
https://www.bda.uk.com/resource/food-facts-eat-well-spend-less.html

Supplements

Supplements are things you can take to add extra nutrients to your diet, like vitamins.

Studies have looked at psoriasis and probiotics, vitamin D, omega-3, B-vitamins, selenium and curcumin.The results are mixed, so **it is hard to say if they can help psoriasis.**

Red flags

These are **warning signs** that a dietary suggestion may not be safe or work. See the advice below for what to watch out for.

You may see **other suggestions on what to eat for psoriasis, that are not in this guide.** This means there haven't been any studies done on them, or very few. If you see or hear of other dietary suggestions, **see the tips below.**

TOP TIPS

Be careful of diets that include any of these:

- Very strict rules
- Say you'll lose weight fast
- Tell you to stop eating a lot of foods
- Say it will cure your psoriasis
- Tell you to stop your medication
- Don't have studies to back them up

Be careful on social media! Make sure information is from a registered nutritionist or dietitian.

Juice cleanses and detox diets can be very strict. Following them might mean you cut out important nutrients.

Medicine and healthy lifestyle changes can help psoriasis. But there is no known cure yet. For health lifestyle tips, visit this link: **https://www.nhs.uk/live-well/**

Always talk to your doctor before you make changes to your medication.

Further information and support

PSORIASIS ASSOCIATION
Email mail@psoriasis-association.org.uk or
WhatsApp 07387 716 439/ Tel: 01604 251 620
Website: https://www.psoriasis-association.org.uk/information-and-support/

HOLD FOR LOGO?

THE PSORIASIS AND PSORIATIC ARTHRITIS ALLIANCE (PAPAA)
Contact: Email: info@papaa.org
Telephone: 01923 672837
Website: https://www.papaa.org/coping/

HOLD FOR LOGO?

University of Hertfordshire UH