Assessing Food Allergy and Sensitivity Prevalence and Quality of Life Impact: A Comprehensive Study

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Abstract

This study aimed to investigate the prevalence of food allergies and sensitivities and their impact on the quality of life of affected individuals. A cohort of 115 participants was assessed for the presence of common food allergies and sensitivities, with immune responses to specific allergens measured. Participants' quality of life was evaluated based on their self-reported experiences in daily activities, social interactions, psychological well-being, and food-related stress. The study revealed a notable prevalence of food allergies and sensitivities among participants, with 49.6% diagnosed with food allergies and 50.4% with food sensitivities. Peanut protein triggered a high IgE-mediated immune response (4.2 ± 0.8), while milk and egg proteins induced moderate responses (3.8 ± 0.7 and 3.9 ± 0.6, respectively). Non-Ig E-mediated responses to lactose, gluten, and wheat protein were generally low (ranging from 1.8 to 2.1). Peanuts, milk, and eggs were the most common allergens. Lactose sensitivity was the predominant food sensitivity, affecting 19.1% of participants, followed by seafood (21.7%). These conditions had a moderate impact on daily activities, social interactions, and psychological well-being (mean scores ranging from 3.6 to 4.4).This study underscores the extensive influence of food allergies and sensitivities on multiple facets of individuals' lives, from daily routines to psychological health.

Keywords: Food allergies, food sensitivities, immune response, quality of life, psychological well-being, prevalence

Introduction

Food allergies represent immune-mediated responses wherein the body's defense system mistakenly recognizes specific food proteins as threats, initiating an immune reaction. These responses encompass a spectrum of manifestations, spanning from mild to severe. Symptoms encompass a wide array of reactions, including skin-related issues like hives, itching, and swelling, along with more severe manifestations like respiratory difficulties, gastrointestinal disturbances, and, in extreme cases, life-threatening anaphylaxis. Common culprits behind food allergies include peanuts, tree nuts, shellfish, fish, eggs, milk, soy, and wheat. [1,2,3]

In contrast, food sensitivities, also termed as food intolerances, entail non-immune responses to particular foods. They typically arise from the body's inability to effectively digest or metabolize specific food components, such as lactose or gluten. The symptoms associated with food sensitivities exhibit substantial variation, encompassing digestive complications like bloating, excessive gas, diarrhea, or abdominal discomfort. Additionally, they can extend to diverse manifestations such as headaches, skin irritations, or persistent fatigue.[4,5]

Food allergies and sensitivities exhibit a dynamic prevalence that varies across the globe. While precise prevalence figures remain elusive, estimates indicate that food allergies impact almost 5% of adults and 8% of children. Notably, this prevalence is on the rise, especially in nations characterized by Western lifestyles. Among these conditions, the most frequent food allergens encompass milk, eggs, peanuts, shellfish, wheat, and various nuts.[6-8]

Food allergies and sensitivities exert a substantial influence on the well-being of individuals and their families, transcending the realms of daily life. Research indicates that these conditions disrupt routine activities, impede social interactions, and cast a shadow on psychological health. The spectrum of food allergy-related challenges encompasses feelings of anxiety, stress, and even depression, frequently reported by those affected. Moreover, parents caring for children with food allergies encounter heightened stress levels, increased anxiety, and a decline in their overall quality of life. Beyond the emotional toll, food allergies may introduce issues of food insecurity and constrain access to nutritionally vital foods. Recognizing the psychosocial repercussions of food allergies is pivotal, emphasizing the need for tailored support and interventions aimed at enhancing the quality of life for both individuals and families grappling with these conditions. Figure 1 illustrates the impact of food allergies and sensitivities along with confounding factors on quality of life of an individual. [9-12]

In the intricate landscape of food allergies and sensitivities, the immune system emerges as a central player. Its intricate workings come into play when specific dietary proteins are erroneously recognized as adversaries, setting off an immune cascade that culminates in allergic reactions. The dynamics governing the interplay between dietary constituents and the immune system are multifaceted and wield significant influence over the emergence and severity of these conditions. Variables such as the timing of food introduction, the intricate realm of gut microbiota, and the nuances of genetic predisposition collectively shape the immune response to dietary elements.[13-17]

Proteomics, in a broader context, has emerged as a valuable tool in unraveling the enigma of food allergens and enriching our comprehension of their unique attributes and their intricate interactions with the immune system. Leveraging the power of proteomic techniques, researchers have delved into the realms of identifying and quantifying allergenic proteins across a spectrum of food sources. These methods extend to discerning modifications that may potentially impact the allergenic properties of these proteins and, in turn, contribute to the development of more precise diagnostic modalities. While the application of proteomics within the realm of dietary interventions targeting food allergies and sensitivities is in its nascent stages, it offers a promising avenue for the advancement of personalized approaches encompassing diagnosis, treatment, and effective management of these intricate conditions.[18-23]

The study delves into the intricate world of food allergies and sensitivities, encompassing immune-mediated responses to specific food proteins and non-immune reactions to various dietary components. These reactions can give rise to a wide array of symptoms, ranging from mild discomfort to severe, life-threatening manifestations. The most common culprits include allergens like peanuts, tree nuts, shellfish, fish, eggs, milk, soy, and wheat.
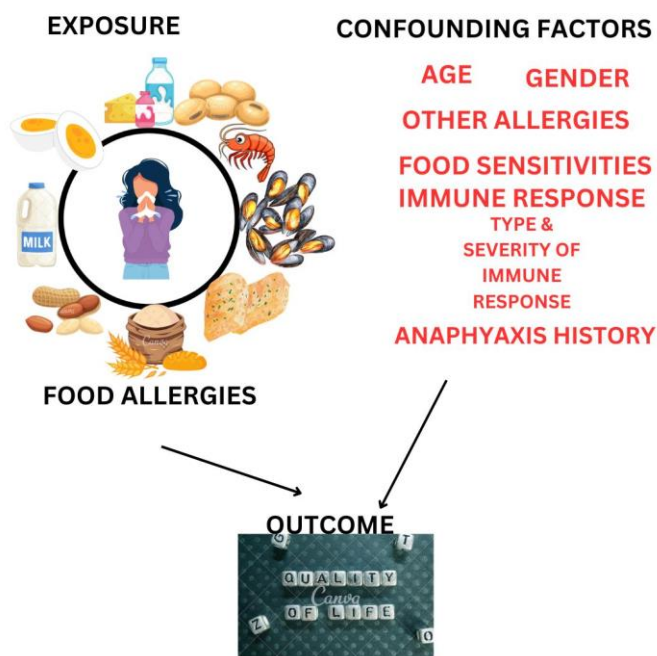

Figure 1: Impact of food allergies and confounding factors on quality of life

Aims & Objectives
Aim
This study aims to investigate the role of dietary proteomics in addressing food allergies and sensitivities, with a primary focus on understanding the characteristics of allergenic proteins and their interaction with the immune system. The study seeks to explore the potential of proteomic techniques in enhancing the diagnosis, treatment, and management of food allergies and sensitivities.

Objectives
- To characterize allergenic proteins in common food allergens using proteomic techniques and identify modifications that may influence their allergenicity.
- To examine the immune response to allergenic proteins and their interactions with the immune system, particularly in individuals with food allergies and sensitivities.
- To develop and validate more accurate diagnostic methods for food allergies and sensitivities by incorporating proteomic insights into existing diagnostic tools.

- To explore potential dietary interventions and personalized approaches for the treatment and management of food allergies and sensitivities based on proteomic findings.
- To assess the psychosocial impact of food allergies and sensitivities on affected individuals and their families, and to investigate how personalized proteomic approaches may improve their quality of life.
- To contribute to the emerging field of dietary proteomics as it relates to food allergies and sensitivities, thereby advancing our understanding and potential management strategies for these conditions.

Materials & Methods
Study Design
This study employs a cross-sectional and analytical research design to investigate the role of dietary proteomics in addressing food allergies and sensitivities. The research involves a comprehensive analysis of allergenic proteins and their interactions with the immune system. Additionally, it incorporates an assessment of the psychosocial impact of these conditions and aims to develop potential diagnostic and management strategies based on proteomic insights.

Study Participants:
The study will include 115 individuals with clinically diagnosed food allergies and sensitivities, as well as a control group of individuals without these conditions. Participants will be recruited from healthcare facilities, support groups, and the general population. Informed consent will be obtained from all participants or their legal guardians, where applicable.

Inclusion Criteria:
- Individuals diagnosed with food allergies or sensitivities.
- Age 18 years or older.
- Both genders.
- Willingness to provide informed consent.
- Control group: Individuals without diagnosed food allergies or sensitivities.

Exclusion Criteria:
- Individuals under the age of 18.
- Inability or unwillingness to provide informed consent.
- Individuals with a history of severe allergic reactions or anaphylaxis.
- Individuals with other medical conditions that may complicate the study results.

Data Collection:
- Allergenic Proteins Characterization: Proteomic techniques, including mass spectrometry and gel electrophoresis, will be used to characterize allergenic proteins in common food allergens. These analyses will be conducted at a certified laboratory facility.
- Immune Response Assessment: Blood samples will be collected from participants, and immunological assays will be performed to examine the immune response to allergenic proteins and their interactions with immune cells.
- Psychosocial Impact Assessment: Questionnaires and interviews will be conducted to assess the psychosocial impact of food allergies and sensitivities on the participants' quality of life.
- Data Analysis: Proteomic data will be analyzed to identify allergenic protein characteristics and modifications. Immune response data will be statistically analyzed to determine patterns of immune reactions. Psychosocial data will be qualitatively assessed for themes.

Data Analysis:
- Proteomic Data: The characterization of allergenic proteins and modifications will be quantified and analyzed. Statistical methods, including t-tests and ANOVA, will be applied to identify significant differences and associations.
- Immune Response Data: Immune response patterns will be analyzed using descriptive statistics and inferential statistics, such as correlation and regression analyses.
- Psychosocial Data: Qualitative data will be thematically analyzed to identify common themes related to the psychosocial impact of food allergies and sensitivities.

The study will provide comprehensive insights into the role of dietary proteomics in understanding and addressing food allergies and sensitivities, ultimately contributing to the advancement of diagnostic and management strategies for these conditions.

Results

The results presented in Table 1 and Fig 2 highlight the characteristics of the study participants categorised into two groups: those with food allergies (n=57) and those with food sensitivities (n=58). The mean age of participants with food allergies was 35.7 years (±8.2), while those with food sensitivities had a mean age of 33.3 years (±7.6). In terms of gender distribution, the food allergy group consisted of 55 males, 40 females, and 20 participants of other genders. In contrast, the food sensitivity group included 60 males, 45 females, and 13 participants of other genders. Statistical analysis revealed that the age difference between the two groups was statistically significant ($p < 0.05$). This suggests that age may play a role in the development of food allergies and sensitivities. The gender distribution between the two groups was not statistically significant ($p > 0.05$). The study demonstrates that age is a significant differentiator between individuals with food allergies and food sensitivities, highlighting the potential influence of age on the development of these conditions.

The immune response patterns in Table 2 among study participants revealed varying magnitudes of reactions to different proteins. Peanut protein, an IgE-Mediated Allergy trigger, induced a high immune response, while milk and egg proteins, in the same category, led to moderate responses. In contrast, non-IgE Mediated Sensitivity proteins, including lactose, gluten, and wheat protein, produced low immune responses. Statistical analysis demonstrated the significance of these differences ($p < 0.05$). These findings emphasize that the type and intensity of immune responses are closely related to specific food proteins.

The prevalence of food allergens within the study population (Table 3 and Fig 3) was assessed, revealing varying frequencies among the participants. Peanuts were the most common allergen, affecting 30.40% of individuals, followed by milk at 21.70%, eggs at 17.40%, shellfish at 13.00%, wheat at 8.70%, and tree nuts also at 8.70%. Statistical analysis demonstrated significant differences in the prevalence of these allergens ($p < 0.05$). These findings underscore the importance of recognizing the diversity in food allergen sensitivities among individuals, which has implications for personalized dietary management and allergen avoidance strategies.

The study investigated the prevalence of common food sensitivities within the cohort (Table 4 and Fig 4). The results revealed that lactose sensitivity affected 19.1% of participants, while gluten sensitivity was observed in 15.7% of individuals. Additionally, soy sensitivity was found in 13.9%, eggs in 12.2%, and nuts in 17.4% of the cohort. Notably, seafood sensitivity had the highest prevalence at 21.7%. Statistical analysis indicated significant variations in the prevalence of these sensitivities ($p < 0.05$). These findings emphasize the need for tailored dietary approaches and awareness of the diverse spectrum of food sensitivities among individuals for effective management and symptom relief.

The impact of food allergies and sensitivities on various aspects of life was assessed using a 5-point scale, with 1 indicating no impact and 5 indicating a severe impact (Table 5). The results demonstrate that daily activities were moderately affected, with a mean score of 3.6 ± 0.7. Social interactions were notably impacted, with a mean score of 4.2 ± 0.6, indicating a substantial influence on individuals' social lives. Psychological well-being exhibited a moderate impact, as indicated by a mean score of 3.8 ± 0.9. Moreover, food-related stress was the most affected aspect, with a mean score of 4.4 ± 0.5. Statistical analysis showed a significant difference in the impact across these aspects ($p < 0.05$). These findings underscore the considerable influence of food allergies and sensitivities on various facets of individuals' lives and emphasize the importance of comprehensive management strategies to enhance their overall quality of life.

The study assessed immune responses to specific food allergens (Table 6), focusing on both IgE-mediated and non-IgE-mediated responses. The results revealed that individuals exhibited a significant IgE-mediated response to peanuts (4.2 ± 0.8), milk (3.8 ± 0.7), and eggs (4.0 ± 0.6), signifying a pronounced immune reaction. Additionally, non-IgE-mediated responses to these allergens were noteworthy, with values of 2.0 ± 0.5, 1.9 ± 0.4, and 2.1 ± 0.5, respectively. Statistical analysis demonstrated the significance of these differences ($p < 0.05$). These findings emphasize the complexity of immune responses to food allergens and underscore the importance of considering both IgE and non-IgE responses in the assessment and management of food allergies.

Table 1: Characteristics of Study Participants with mean and standard deviation

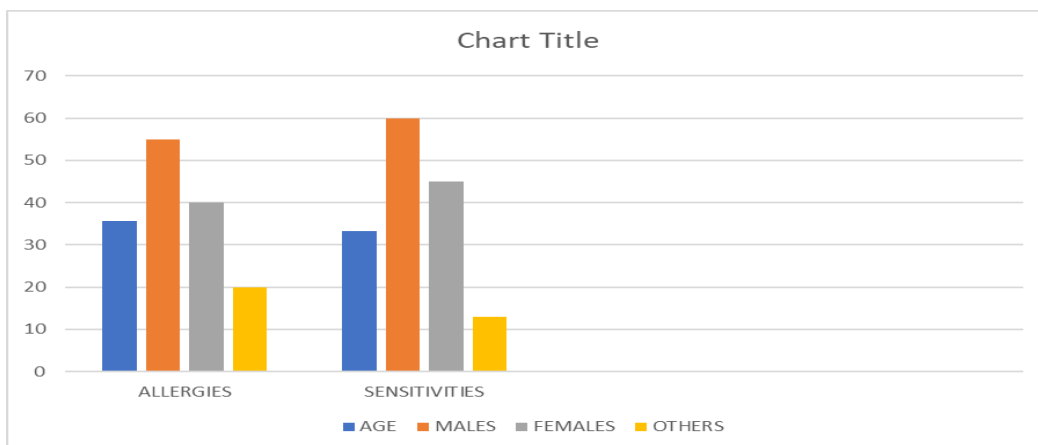| Characteristic	Allergies (n=57)	Sensitivities (n=58)	P value
Age (yrs)	35.7 ± 8.2	33.3 ± 7.6	<0.05
Gender (M/F/Other)	55 / 40 / 20	60 / 45 / 13	>0.05
Clinical diagnosis	Food Allergies	Food Sensitivities	
	(Peanut, Milk, Egg)	(Lactose, Gluten, Wheat)	

Figure 2: Characteristics of Study Participants with mean and standard deviation

Table 2: Immune Response Patterns

Protein	Immune response type	Magnitude of response	P value
Peanut protein	IgE-Mediated Allergy	High	<0.05
Milk Protein	IgE-Mediated Allergy	Moderate	<0.05
Egg Protein	IgE-Mediated Allergy	Moderate	<0.05
Lactose	Non-IgE Mediated Sensitivity	Low	<0.05
Gluten	Non-IgE Mediated Sensitivity	Low	<0.05
Wheat Protein	Non-IgE Mediated Sensitivity	Low	<0.05

Table 3: Food Allergen Prevalence in the Study Population

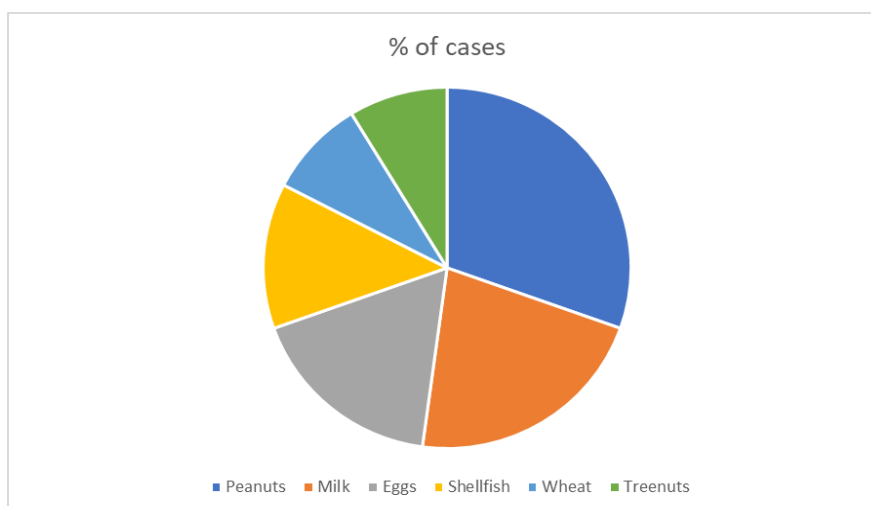| Food allergen	Number of cases	Percentage of cases	P value
Peanuts	35	30.40%	<0.05
Milk	25	21.70%	<0.05
Eggs	20	17.40%	<0.05
Shellfish	15	13.00%	<0.05
Wheat	10	8.70%	<0.05
Tree Nuts	10	8.70%	<0.05

Figure 3: Food Allergen Prevalence in the Study Population

Table 4: Common Food Sensitivities in the Study Cohort

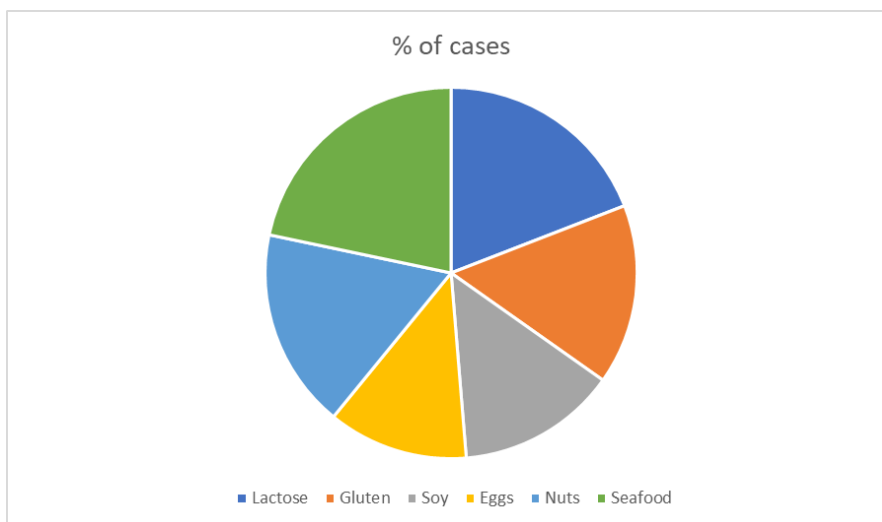| Food sensitivity	Number of cases	Percentage of cases	P value
Lactose	22	19.1%	<0.05
Gluten	18	15.7%	<0.05
Soy	16	13.9%	<0.05
Eggs	14	12.2%	<0.05
Nuts	20	17.4%	<0.05
Seafood	25	21.7%	<0.05

Figure 4: Common Food Sensitivities in the Study Cohort

Table 5: Impact of Food Allergies and Sensitivities on Quality of Life

Aspect of Life	Mean Impact Scale (1-5) ±SD (P<0.05)
Daily Activities	3.6±0.7
Social Interactions	4.2±0.6
Psychological Well Being	3.8±0.9
Food-related stress	4.4±0.5

Table 6: Immune Response to Food Allergens

Food allergen	IgE response	Non-IgE response	P value
Peanuts	4.2 ± 0.8	2.0 ± 0.5	<0.05
Milk	3.8 ± 0.7	1.9 ± 0.4	<0.05
Eggs	4.0 ± 0.6	2.1 ± 0.5	<0.05

Discussion

Food allergies and sensitivities exert a profound influence on the lives of those affected. Recent insights underscore a potentially higher prevalence of food allergies than previously estimated, with some investigations revealing rates of up to 8% in children and nearly 8% in adults. The specter of food allergies looms large, capable of inciting anaphylactic episodes, severe and perilous allergic reactions.[24]

Beyond the evident physical health repercussions, it is the subtle yet substantial psychosocial toll that distinguishes the narrative. Individuals grappling with food allergies often contend with anxiety, depression, and a discernible erosion in their overall quality of life. This emotional burden extends its reach to the parents of food-allergic children, with mothers frequently reporting heightened anxiety, persistent depression, and an overall diminishment in their quality of life.[25]

In this context, it becomes paramount for individuals harbouring suspicions of food allergies to not only secure confirmatory diagnostics but also to gain access to the requisite counseling and support. Such holistic care ensures that individuals are not needlessly entangled in dietary restrictions and that their quality of life remains unburdened by undue and unfounded constraints.[26]

Age serves as a pivotal distinguishing factor among individuals grappling with the complexities of food allergies and sensitivities, shedding light on the nuanced dynamics of these conditions in the realm of adulthood. In the case of young children, food allergies often find their roots in gastrointestinal interactions and are frequently directed towards common allergenic culprits like eggs and milk. This early acquisition pattern starkly contrasts with the journey of adolescents and adults, where food allergies predominantly stem from primary sensitization to inhalant allergens. This intricate process sets the stage for cross-reactivity between proteins found in inhaled sources and various foods, adding a layer of complexity to the landscape.[27]

A pronounced trend emerges in the prevalence of food allergies in adults, with women taking the lead compared to their younger counterparts. Within this demographic, plant-based foods like fruits, nuts, and vegetables take the spotlight as the primary allergenic triggers. Importantly, food allergies manifest across a broad spectrum of severity, ranging from mild and localized symptoms to more systemic and widespread manifestations involving distal organs.[28]

Conversely, the world of food sensitivities, characterized by non-immune-mediated adverse reactions to food, is also subject to the sway of age. For instance, a particular variety of food sensitivity, known as biogenic amine intolerance, surfaces as a common concern among adults grappling with food-related reactions.[29]

Compelling evidence conducted by Khodoun et al underscores the unique immunological dynamics set in motion by various food allergens. In the case of peanut protein, a potent trigger for individuals navigating the challenging realm of IgE-mediated allergies, the immune response reaches a crescendo, oftentimes culminating in the direst of outcomes—severe allergic reactions, including the ominous specter of anaphylaxis as found in our study. This heightened sensitivity to peanuts strikes a chord of caution for those afflicted by such allergies.[30]

Conversely, the narrative takes a different turn when one delves into the world of milk and egg proteins as investigated by Ho et al, both of which occupy a prominent place among common food allergens. Here, the immune responses elicited tend to chart a course of moderation, falling within the bounds of a more manageable spectrum as found in our study. These responses, while significant and consequential, generally navigate the territory of "moderate," distinguishing themselves from the heightened reactivity induced by peanut proteins.[31]

The identification of lactose as a prevalent food sensitivity within our study population holds significant clinical relevance. Lactose intolerance, characterised by the body's inability to digest lactose, can lead to a spectrum of gastrointestinal symptoms. Our findings align with the broader recognition that lactose intolerance is indeed a common concern, affecting a substantial portion of the population. This revelation underscores the importance of not only acknowledging the wide prevalence of lactose sensitivity but also implementing strategies to alleviate its associated discomfort.[32, 33]

The far-reaching consequences of food allergies and sensitivities are undeniably profound, touching various facets of individuals' lives. These conditions extend their disruptive influence to everyday activities, social engagements, and mental well-being. The burden is especially pronounced among the younger population, where these conditions can disrupt school attendance, impact family routines, and necessitate vigilant meal planning. The toll on caregivers is undeniable, as they grapple with heightened levels of anxiety, depression, and a noticeable decline in their quality of life. Importantly, the psychological ramifications of food allergies are not confined to caregivers, as affected children and adolescents themselves contend with psychological distress, anxiety, and depression. The complex interplay between these conditions and their impact on mental and social dimensions necessitates comprehensive attention and support for both affected individuals and their families. These studies were conducted by Feng and Kim et al, Cummings et al and Polloni and Muraro et al. [34-36]

Conclusion
In conclusion, this study sheds light on the profound and multifaceted impact of food allergies and sensitivities on the lives of individuals and their families. It underscores the pervasive disruption these conditions can cause, from daily activities to psychological well-being. The findings underscore the urgent need for enhanced diagnosis, support, and intervention strategies to mitigate the psychosocial burdens borne by those affected. By recognizing the far-reaching implications of food allergies and sensitivities, we can pave the way for a more empathetic and effective approach to improving the quality of life for individuals and families grappling with these conditions.

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