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NUTRITIONAL MANAGEMENT OF CHILDREN WITH ATTENTION DEFICIT/HYPERACTIVITY DISORDER (ADHD) AND AUTISM SPECTRUM DISORDER (ASD): DIETITIANS' PERSPECTIVES, CLINICAL PRACTICES, AND RECOMMENDATIONS

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Abstract

This study examined dietitians' perspectives, clinical practices, and recommendations regarding the nutritional management of children with Attention-Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD) in Pakistan. A quantitative cross-sectional survey was conducted with 412 registered dietitians across public hospitals, private clinics, community health centres, and academic institutions. Data were collected using a structured questionnaire assessing nutritional knowledge, assessment practices, dietary interventions, supplementation, barriers, caregiver engagement, and attitudes toward emerging approaches. Findings showed moderate knowledge of ADHD and ASD nutritional management, with a stronger understanding of micronutrient deficiencies than gut–brain axis and supplementation practices. Higher qualifications and longer professional experience were significantly associated with better knowledge scores. Common interventions included reducing refined sugar, structured meal schedules, eliminating artificial additives, food texture modification, and gluten-free/casein-free diets. Major barriers were insufficient training, limited consultation time, lack of local guidelines, and poor caregiver adherence. The study highlights the need for specialized training, standardized protocols, and multidisciplinary care.

1. INTRODUCTION

Neurodevelopmental disorders, such as the attention-deficit/hyperactivity disorder (ADHD) and autism spectrum disorder (ASD) are among the most common disorders in children around the world. The estimated prevalence for Reactive Attachment Disorder in the United States is 1 in 36 school-aged children, with figures increasing steadily in all world regions, and ASD is estimated to affect approximately 5–7% of school-aged children globally (Maenner et al., 2023; Polanczyk et al., 2015). Both disorders are accompanied by large cognitive, behavioral, social, and nutritive comorbidities and have a significant impact on the children's quality of life, especially gastrointestinal and nutritional disorders, which pose special

challenges for management of the children's disorders (Heilskov Rytter et al., 2015). The real epidemiological impact of ADHD and/or ASD in Pakistan is not well documented because of lack of diagnostic facilities, sociocultural stigma of mental health care facilities, and lack of any national neurodevelopmental surveillance system (Imran et al., 2020). Often children in Pakistan with these conditions are treated with little or no formal nutrition intervention, and their care is fragmented and based on medications. This is especially the case in the context of the strong and expanding evidence linking nutritional status, diet and gut microbiome composition with mechanisms of neurotransmitter synthesis, neuroinflammation, synapse function and behaviour in neurodevelopmental disorders (Jacka et al., 2017). Addressing the nutritional dimensions of ADHD and ASD management is therefore both clinically imperative and significantly underexplored in the Pakistani context.

1.2 Nutritional Challenges in ADHD

Children with ADHD have multiple documented micronutrient deficiencies affecting primary symptomology. Low levels of iron, zinc and magnesium in the serum have been reported consistently in children with ADHD compared to neurotypical children and have been associated with altered dopaminergic neurotransmission, decreased prefrontal cortical function and increased inattention and hyperactivity (Robberecht et al., 2020). In addition, brain iron levels (specifically thalamic) have been shown to be significantly lower in ADHD, indicating neurological iron insufficiency that is not captured by systemic markers (Degremont et al., 2021). Vitamin D deficiency is also known to be a powerful correlate in the severity of ADHD; and the meta-analysis showed a significantly reduced 25-hydroxyvitamin D level in ADHD children compared to controls (Kotsi et al., 2019). Omega-3 polyunsaturated fatty acids, such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), play a crucial role in maintaining the integrity of the neuronal membrane and in regulating inflammation, and a deficiency of omega-3 fatty acids has been linked to impairment in attentional function and impulsive behavior (Lange et al., 2023). Supplementation trials have yielded inconsistent results, but pretreatment omega-3 status seems to moderate therapeutic response, highlighting the importance of individual biochemical assessment of status before supplementation (Lange et al., 2023). The dietary patterns level shows that adherence to Western food pattern, which is high in refined sugar, artificial additives and processed food, is positively correlated with the severity of ADHD symptoms, while the adherence to Mediterranean and DASH dietary patterns is correlated inversely with the risk of ADHD disorder (Shareghfarid et al., 2020). Artificial food colouring and preservatives have also been suspected as triggers for behaviours for some subgroups of children with ADHD (Phillips, 2014). Trials of the few-foods or oligoantigenic diet (most foods are removed before controlled reintroduction) have shown that up to 60% of children respond to this intervention, suggesting that there is a meaningful food-sensitivity subtype of ADHD (Pelsser et al., 2011). In addition, stimulant medications like methylphenidate that are effective for controlling core symptoms result in substantial suppression of appetite, which may impair intake of macronutrients, linear growth and micronutrient status, and require careful dietary monitoring and individual nutritional planning (Phillips, 2014).

1.3 Nutritional Challenges in ASD

Children with ASD have a complex nutritional profile, which is directly affected by the key features of the disorder. In most children with sensory processing abnormalities, the texture, taste, temperature and smell of food are hypersensitive, leading to significantly limited food selections and chronic failure to eat a variety of foods that result in multiple micronutrient deficiencies (Cermak et al., 2010). Common deficiencies documented are Vitamin D, Vitamin B12, folate, zinc, iron, calcium and omega-3 fatty acids, each having its own physiological and neurological implications such as compromised bone health, immune dysfunction, impaired

growth, and increased behavioral symptoms (Adams et al., 2011; Al-Beltagi, 2024). Up to 70% of people with ASD experience gastrointestinal comorbidities, and they are associated in both directions with dietary consumption, dysbiosis of the gut microbiome, and core behavioral symptoms via the gut-brain axis (Madra et al., 2021). While there is limited randomized controlled trial evidence for most dietary interventions, they all aim to address a specific pathophysiological mechanism, including the opioid excess, the neuroinflammation, and the gut dysbiosis, and include the gluten-free and casein-free (GFCF) diet, the ketogenic diet, the Specific Carbohydrate Diet (SCD), and the GAPS protocol (Karhu et al., 2020). For each supplementation strategy, there is a preliminary evidence base which needs to be interpreted by the expert clinician and applied to the individual patient (Al-Beltagi, 2024).

1.4 Role of Dietitians in MDT Care

Registered dietitians are uniquely placed in multidisciplinary teams (MDT) to perform a full nutrition assessment, address micronutrient deficiencies, plan for individual dietary needs, support sensory feeding issues, and continue evidence-based care provider education for children with ADHD and ASD (Sharp et al., 2019). Even with the significant role play, dietitians are under-represented in the pathway of care for neurodevelopment in Pakistan. Pediatric dietetic services are mainly provided at tertiary care centers in urban areas and community based integration is limited; there are no clinical guidelines available specific to Pakistan that address the nutrition care management of these conditions. This gap between evidence and practice highlights the need to assess the current evidence base of dietitians and their knowledge, clinical practice, attitudes and training regarding this specific area.

1.5 Study Objectives

This study aims to: (1) assess the nutritional knowledge of registered dietitians in Pakistan regarding ADHD and ASD management; (2) describe their commonly used dietary assessment methods and intervention strategies; (3) examine supplementation recommendation and monitoring practices; (4) identify perceived barriers to evidence-based nutritional care delivery; (5) explore caregiver engagement and follow-up practices; (6) examine dietitians' attitudes toward emerging nutritional approaches; and (7) determine whether knowledge levels differ according to academic qualification and years of professional experience.

1.6 Research Questions

RQ1: What is the level of nutritional knowledge among Pakistani dietitians regarding ADHD and ASD?
RQ2: What dietary assessment methods and intervention strategies are most commonly used by dietitians in clinical practice?
RQ3: What supplementation recommendation and monitoring practices are used by dietitians for children with ADHD and ASD?
RQ4: What are the primary perceived barriers to evidence-based nutritional management of children with ADHD and ASD?
RQ5: What caregiver engagement and follow-up practices are commonly used by dietitians?
RQ6: What are dietitians' attitudes toward emerging nutritional approaches for ADHD and ASD?
RQ7: Do dietitians' ADHD and ASD knowledge scores differ according to academic qualification and years of professional experience?

2. LITERATURE REVIEW

2.1 Nutritional Assessment in ADHD and ASD

The nutritional assessment is a crucial cornerstone of clinical management for children with ADHD and ASD that is not uniformly implemented in health care settings. A detailed assessment protocol incorporates dietary history using validated instruments such as 24-hour dietary recalls, 3-7 days food diaries and food frequency questionnaires to systematically assess nutrient gaps, limited food intakes, and disordered eating patterns (Ranjan & Nasser, 2015). Anthropometric assessment (BMI for age, head circumference in early childhood, MUAC) is essential to monitor growth trends and identify under nutrition or overweight in

neurodevelopmental groups, where it is more prevalent than in the rest of the population (Marí-Bauset et al., 2014). Biochemical markers such as serum ferritin, zinc, magnesium, 25-hydroxyvitamin D, Vitamin B12, folate, complete blood count and essential fatty acid profiles can be used to determine a biochemical state of deficiency and are more objective than dietary assessments, and can reveal subclinical deficiencies that dietary history may not accurately capture (Kawicka & Regulska-Ilow, 2013). Feeding behaviour screening is conducted using standardized tools and targets oral-motor deficits, sensory food aversions, mealtime behavioral difficulties and feeding practices of the caregiver, with particular attention to the feeding behavior in children with ASD, a clinical dimension that is of particular importance, and demands specific assessment and interprofessional management (Esposito et al., 2023).

2.2 Evidence on Dietary Interventions — ADHD

The evidence base for dietary interventions for ADHD has expanded considerably and there is significant heterogeneity of findings across intervention categories. A randomized double-blind trial showed a significant decrease in conduct problems, emotional difficulties and peer relationship problems in children with ADHD when supplemented with a combination of magnesium and Vitamin D compared to placebo controls over eight weeks (Hemamy et al., 2021). Six zinc supplementation trials were included in a dose-response meta-analysis, which showed improvements in total ADHD symptom scores were statistically significant and more beneficial with longer supplementation duration, though were generally of moderate to low evidence certainty across the trials (Talebi et al., 2021). The clinical relevance of biochemical screening before intervention (Granero et al., 2021) has been highlighted in the case of iron-zinc combined supplementation for children with confirmed iron and/or zinc deficiency who were found to have ADHD. Evidence for the benefits of omega-3 PUFAs supplementation is still controversial. The core symptoms of ADHD did not significantly improve in a more extensive meta-analysis of 31 trials (Händel et al., 2021), although significant improvement was seen on the clinical symptom scores and cognitive measures related to attention in a meta-analysis of 7 randomized trials (Chang et al., 2018), thus underlining the importance of pre-treatment omega-3 status in moderating therapeutic response. The few-foods or oligoantigenic diet has yielded the most clinically significant results, and has been shown to result in dramatic behavioral improvements in an unselected sample of children with ADHD following 5 weeks of dietary elimination, with long-term followup showing continued symptom improvement up to 3.5 years in dietary responders (Pelsser et al., 2011; Walz et al., 2022). A matched case-control study found that adherence to the Mediterranean diet was inversely correlated with the risk of ADHD, and a 12-week randomized trial revealed significant improvements in several behavioral domains with the DASH diet (Darabi et al., 2022; Khoshbakht et al., 2021). A pilot randomized trial of three months of probiotic supplementation of Lactobacillus rhamnosus GG in drug-naïve children with ADHD showed significantly improved health-related quality of life and emotional functioning, and this was correlated with improvements in ADHD symptoms (Kumperscak et al., 2020).

2.3 Evidence on Dietary Interventions — ASD

Dietary intervention research in ASD has a wider variety of approaches that represent the complexity of the syndrome's nutritional and gastrointestinal (GI) comorbidities. The gluten-free and casein-free (GFCF) diet is the most common dietary intervention used in ASD and is believed to treat opioid excess by eliminating gluten and casein derived peptides, and to minimize disruption of the gut-brain axis by decreasing intestinal permeability (Piwowarczyk et al., 2018). Nevertheless, although there is some preliminary evidence of positive changes in gastrointestinal symptoms, behaviour and social interaction, systematic reviews indicate methodological problems and recommend further larger, adequately powered randomized controlled trials, before clinical recommendations can be made (Baspinar & Yardimci, 2020). The ketogenic

diet has been proposed for targeting neuroinflammation and mitochondrial dysfunction via neuroprotective mechanisms mediated by ketones, and early results suggest that the diet can be beneficial for behavioral and cognitive outcomes in ASD, but the strict macronutrient ratios involved present a significant challenge for adherence and require careful supervision by a dietitian to ensure dietary balance and avoid nutritional deficiencies (Li et al., 2021). The Specific Carbohydrate Diet focuses on gut dysbiosis by avoiding fermentable carbohydrates that can encourage pathogenic bacterial overgrowth and the GAPS Diet expands on this and adds a phased approach to gut healing that includes bone broths, fermented foods, and anti-inflammatory fats – but there is limited peer-reviewed clinical evidence to support these two diets specifically for ASD (Ābele et al., 2021). High dose methylcobalamin has shown clinical efficacy, with randomized controlled trials (RCTs) showing that treated children had marked increases in methylation capacity, decreased oxidative stress markers and decreased clinician-rated scores for symptomology of ASD (Hendren et al., 2016). In the meta-analytical evidence, prenatal folic acid supplementation has been linked to a 58% decreased risk of ASD, and is thought to act through two mechanisms: normalization of DNA methylation and support for neurotransmitter synthesis (Iglesias Vázquez et al., 2019). Several clinical trials have reported that probiotic strains of Lactobacillus and Bifidobacterium have shown beneficial effects on gastrointestinal symptoms, stereotypical behaviors, and hyperactivity, and prebiotics with short-chain fatty acid-producing properties may be a complementary immune modulation and gut barrier integrity strategy in autism (He et al., 2023). The effects of omega-3 supplementation on social behavior, communication and hyperactivity in ASD have been inconsistent, and L-carnitine supplementation at the dosage range of 50–100 mg/kg/day has been found to improve social behavior, communication, and overall scores reflecting severity of ASD in controlled trials, likely due to its effects on mitochondrial fatty acid oxidation and reducing oxidative stress (Demarquay & Demarquay, 2019). Camel milk, which is a source of highly concentrated lactoferrin, immunoglobulins, antioxidant enzymes and unique anti-inflammatory bioactive proteins, is culture important to Pakistan and the South Asian/Middle Eastern population, and research interest has begun into the potential of this accessible complementary intervention for ASD, where several studies have reported significant behavioral improvements, reduced oxidative stress, and enhanced cognitive function after regular consumption (Al-Ayadhi et al., 2015). The fundamental principles of nutrition management in ASD include feeding therapy and behavior management. Multiple studies have shown that multidisciplinary feeding therapy with oral-motor skill development, sensory integration techniques, graduated food exposure, positive reinforcement strategies, and structured mealtime routines has led to an improvement in food acceptance, variety in food intake, and nutritional intake in children with ASD (Reche-Olmedo et al., 2021).

2.4 Dietitians' Knowledge, Attitudes, and Practices

Although there is an increasing evidence base, there are still a number of gaps between research evidence and dietetic clinical practice in neurodevelopmental nutrition. The knowledge-attitude-practice profiles of dietitians and allied health professionals in this domain have found that key practice deficits are limited formal education, lack of awareness of specific dietary guidelines for conditions, inadequate integration of the nutrition professional into a multidisciplinary neurodevelopmental team, and inconsistent use of validated nutrition assessment tools (Blaine et al., 2023). The main challenges to clinical management are lack of time, institutional resources, low health literacy of the caregivers, financial limitations on dietary adherence, cultural factors influencing food acceptance, and the lack of locally relevant evidence-based clinical guidelines. The most common professional development needs reported in the literature are expertise in neurodevelopmental nutrition, feeding therapy approaches, micronutrient

assessment and supplementation protocols, gut-brain axis therapeutics, caregiver behavior change communication, and interdisciplinary team-based care skills (Conti et al., 2023).

2.5 Pakistan Context

Pakistani children have alarmingly high prevalence of micronutrient deficiencies such as those of iron deficiency anemia (around 62% of children under five years in Pakistan are iron deficient) and wide-spread Vitamin D insufficiency, which are similar to deficiencies found in ADHD and ASD children around the world (Akhtar et al., 2013). Pre-existing nutrition vulnerabilities may worsen the neuro-developmental risk and clinical symptoms in Pakistani children with ADHD and ASD but there is limited evidence of targeted nutrition management in the clinical pathway of care. Bottlenecks in health services access, such as geographic lack of access, especially in the rural and peri-urban settings – and out-of-pocket financial requirements, serious insufficient numbers of trained pediatric dietitians in health sector facilities, and poor referral systems – significantly restrict the provision of specialized nutrition services to affected families (Imran et al., 2020). Other cultural issues, such as traditional food beliefs (highly entrenched among both children and caregivers), meal patterns that typically include family meals, religious dietary rules during Ramadan and other holidays, socioeconomic food insecurity, and high consumption of complementary foods and herbal remedies also influence dietary behaviour and the receptivity of caregivers to professional, evidence-based dietary advice. The study aims to identify the current landscape of dietetic knowledge and practice in children with ADHD and ASD in Pakistan, to highlight any gaps and to begin remedying this situation, both structurally and in terms of knowledge, through systematic documentation and reporting.

3. METHODOLOGY

The study was designed as a quantitative descriptive cross-sectional survey to determine the nutritional knowledge, clinical assessment practices, dietary intervention strategies, supplementation practices, perceived barriers, caregiver engagement practices, attitudes towards emerging nutritional approaches, and professional development needs of registered dietitians in Pakistan for nutritional management of children with ADHD and ASD.

The target group included registered dietitians working in various clinical and academic environments of public hospitals, private clinics, community health centres, and academic centres of major cities like Lahore, Karachi, Islamabad, Peshawar and Quetta. Purposive sampling along with snowball sampling was employed as there was no National register of registered dietitians in Pakistan.

The sample size was computed using the formula for the single population proportion ($n = Z^2pq/d^2$) where it was assumed that 50% of the population had adequate knowledge, a 95% confidence level and a 5% margin of error. The minimum sample size calculated was 384. The final target sample was 442 after accounting for a 15% non-response. The final analysis included 412 respondents.

All participants had to have a recognized qualification in dietetics or clinical nutrition and be actively involved in clinical dietetics work, and give informed consent. Retired dietitians, dietitians who work in food service management but have not completed credentials and those still in training were not included.

A structured purpose-built questionnaire with nine sections and 38 items was used to collect data, which was self-administered. Demographic background, nutritional knowledge about ADHD and ASD, clinical assessment practices, dietary intervention strategies, supplementation recommendation practices, supplementation monitoring practices, perceived barriers, involvement of caregivers and follow-up practices, attitudes towards emerging nutritional therapies, were all examined.

Summative scoring system was used to derive composite knowledge scores for the knowledge items, and the clinical practice items, attitude and barrier items were measured with five-point Likert scales. Content validity was achieved by the review by five subject matter experts, including pediatric

dietitians, a child neurologist and an ASD specialist. Lynn (1986) determined that an IRC of 0.80 or higher was necessary for item retention.

The Cronbach's alpha was used to assess the internal consistency with ≥ .70 considered acceptable (Taber, 2018). In order to test the questionnaire, the researcher conducted a pilot study with 30 dietitians who were not included in the main study sample and made the necessary changes before collecting full data.

The questionnaire was sent via Google Forms online and sent in hard copy over the six week period of data collection. Prior to data collection, the Institutional Review Board of the affiliated institution has given permission for ethical approval. No personally identifiable information was collected and informed consent was obtained, and participation was voluntary.

IBM SPSS Statistics 26.0 was used to perform statistical analysis. All relevant variables were analysed using descriptive statistics like frequencies, percentages, means and standard deviations. Independent samples t-tests, one way ANOVA, Chi-square tests, and correlation analysis were used for inferential analyses to determine group differences and associations among selected variables. A p-value cut-off of < 0.05 was used to determine statistical significance.

Results

Table 1: Demographic and Professional Profile of Respondents (N = 412)

Variable	Category	n	%
Age	< 25 years	78	18.9
	25–34 years	186	45.1
	35–44 years	98	23.8
	45–54 years	38	9.2
	≥ 55 years	12	2.9
Gender	Female	334	81.1
	Male	78	18.9
Qualification	Bachelor's Degree	198	48.1
	Postgraduate Diploma	64	15.5
	Master's Degree	118	28.6
	Doctorate (PhD)	32	7.8
Years of Experience	< 2 years	82	19.9
	2–5 years	148	35.9

Variable	Category	n	%
	6–10 years	96	23.3
	11–20 years	62	15.0
	> 20 years	24	5.8
Practice Setting	Public hospital/tertiary care	142	34.5
	Private hospital/clinic	118	28.6
	Private practice (outpatient)	74	18.0
	Community health centre	42	10.2
	Academic/research institution	36	8.7
MDT Involvement	Yes, regularly	86	20.9
	Yes, occasionally	138	33.5
	No, but refer to others	142	34.5
	No	46	11.2

Note. *MDT = Multidisciplinary Team. Total response rate = 93.2% (412/442). Respondents could report multiple specialties.*

Table 1 reveals that females predominated in the respondents (81.1%) and the age group 25-34 years is the age group with the highest number of respondents (45.1%). Almost half possessed a bachelor's degree (48.1%) and 28.6% of them had a master's degree. The majority of the participants (35.9%) had a professional experience of 2-5 years. The majority of workers were in the public hospitals/tertiary care setting (34.5%). As for MDT involvement, 33.5% take part occasionally, 20.9% take part regularly.

Table 2**: Dietitians' Knowledge of Nutritional Management for Children With ADHD and ASD**

Knowledge domain	M	SD
ADHD nutritional knowledge (total/20)	11.4	3.2
ASD nutritional knowledge (total/20)	10.8	3.6

Knowledge domain	M	SD
Gut-brain axis knowledge	2.6	1.1
Micronutrient deficiency knowledge	3.8	1.4
Dietary intervention knowledge	3.2	1.3
Supplementation knowledge	2.8	1.2

Table 2 shows the mean scores for dietitians for different areas of knowledge about the nutrition management of children with ADHD and ASD. The level of knowledge about micronutrient deficiencies was the highest (M = 3.8, SD = 1.4), followed by knowledge about the gut–brain axis (M = 2.6, SD = 1.1) and supplementation (M = 2.8, SD = 1.2). Overall the results suggest moderate level of knowledge of nutrition related concepts that are relevant to managing ADHD and ASD.

Table 3: One Way ANOVA for dietitians' knowledge scores about ADHD and ASD by qualification and years of experience

Variable	Grouping factor	df	F	p	η^2
ADHD knowledge	Qualification	3, 408	42.86	< .001	.24
ASD knowledge	Qualification	3, 408	39.72	< .001	.23
ADHD knowledge	Years of experience	4, 407	36.45	< .001	.21
ASD knowledge	Years of experience	4, 407	34.18	< .001	.20

Note. η^2 *= eta squared effect size. One-way ANOVA was used to compare knowledge scores across qualification and years-of-experience groups.*

Table 3 shows the analysis of the one-way ANOVA to compare means for the dietitians' knowledge scores for ADHD and ASD across academic qualification and years in practice. Significant differences were observed across qualification levels for ADHD knowledge, $F(3, 408) = 42.86$, $p < .001$, $\eta^2 = .24$, and ASD knowledge, $F(3, 408) = 39.72$, $p < .001$, $\eta^2 = .23$. Similarly, significant differences were found across years-of-experience groups for ADHD knowledge, $F(4, 407) = 36.45$, $p < .001$, $\eta^2 = .21$, and ASD knowledge, $F(4, 407) = 34.18$, $p < .001$, $\eta^2 = .20$. The results showed that the more educated and experienced (in terms of years of professional practice) the dietitian was, the more knowledge they had on the nutritional management of ADHD and/or ASD in children.

Table 4: **Clinical Assessment Practices Used by Dietitians in the Nutritional Management of Children With ADHD and ASD**

Assessment category	Tool/measure	n	%
Dietary assessment methods	24-hour dietary recall	286	69.4
	Food frequency questionnaire	198	48.1
	Diet history interview	168	40.8
	3–7 day food diary	142	34.5
	Validated feeding behaviour screening tool	64	15.5
	No formal dietary assessment tools used	82	19.9
Anthropometric measures	Weight	386	93.7
	Height/length	374	90.8
	BMI-for-age	298	72.3
	Head circumference	148	35.9
	Mid-upper arm circumference (MUAC)	124	30.1
	Skinfold thickness	62	15.0
Laboratory investigations	Complete blood count	224	54.4

Assessment category	Tool/measure	n	%
	Serum ferritin/iron studies	196	47.6
	25-OH vitamin D	186	45.1
	Vitamin B12 and folate	172	41.7
	Serum zinc	168	40.8
	Food allergy/intolerance panel	86	20.9
	Omega-3/fatty acid profile	64	15.5
	Gut microbiome/stool analysis	38	9.2
	Do not routinely request investigations	128	31.1

Note. Respondents could select multiple options. BMI = body mass index; MUAC = mid-upper arm circumference.

Table 4 shows the clinical assessment practices of the dietitians for the nutritional management of children with ADHD and ASD. The 24-hour dietary recall was the most frequently used dietary assessment tool (69.4%), and the food frequency questionnaire (48.1%) and diet history interview (40.8%) were the next. Anthropometric assessment was very common, with weight (93.7%), height/length (90.8%), and BMI-for-age (72.3%) being the most common measurements. Complete blood count (54.4%), serum ferritine/iron studies (47.6%) and 25-OH vitamin D assessment (45.1%) were the most common laboratory investigations. The general results suggest that simple dietary and anthropometric measurements are frequently used, whereas specialized instruments, like feeding behaviour screening, fatty acid analysis and gut microbiome analysis, are not used as often.

Table 5: Dietary Interventions Recommended by Dietitians for Children With ADHD and ASD

Dietary intervention	ADHD n	ADHD %	ASD n	ASD %
Reduced refined sugar/processed food intake	312	75.7	278	67.5
Structured meal/snack schedule	298	72.3	262	63.6
Elimination of artificial additives/colorings	286	69.4	248	60.2
Omega-3 supplementation	198	48.1	186	45.1
Iron supplementation	168	40.8	154	37.4
Gluten-free/casein-free diet	42	10.2	196	47.6
Food texture modification	28	6.8	198	48.1

Dietary intervention	ADHD n	ADHD %	ASD n	ASD %
Probiotic/prebiotic supplementation	112	27.2	148	35.9
Zinc supplementation	142	34.5	136	33.0
Magnesium supplementation	118	28.6	108	26.2
Mediterranean-style diet	124	30.1	96	23.3
Ketogenic diet	18	4.4	72	17.5
No specific dietary interventions implemented	86	20.9	78	18.9

Note. Respondents could select multiple options. ADHD = attention-deficit/hyperactivity disorder; ASD = autism spectrum disorder.

Table 5 shows the dietary interventions recommended by dietitians for children with ADHD and ASD. The most common recommendations for ADHD were decreasing refined sugar and processed food (75.7%), structured meal and snack times (72.3%), and avoiding artificial additives or food colorings (69.4%). Other recommendations, such as food texture modification (48.1%), and gluten-free/casein-free diets (47.6%) were also more frequently reported for ASD than ADHD. Moderate supplementation in both groups included: omega-3, iron, zinc, magnesium, and probiotics. In general, the results indicate that dietary regulation strategies for ADHD are more likely to be practical, whereas sensory-related feeding strategies and selective dietary restrictions are more likely to be used for managing ASD.

Table 6: Supplementation Recommendation and Monitoring Practices Among Dietitians

Variable	Category	n	%
Supplement recommendation for ADHD	Always (> 90% of cases)	28	6.8
	Often (51–90%)	86	20.9
	Sometimes (26–50%)	148	35.9
	Rarely (1–25%)	112	27.2

Variable	Category	n	%
	Never	38	9.2
Supplement recommendation for ASD	Always (> 90% of cases)	34	8.3
	Often (51–90%)	96	23.3
	Sometimes (26–50%)	154	37.4
	Rarely (1–25%)	98	23.8
	Never	30	7.3
Post-supplementation monitoring	Yes, always	62	15.0
	Yes, usually	118	28.6
	Sometimes	142	34.5
	Rarely	64	15.5
	Never	26	6.3

Note. Always or often recommending supplementation was reported by 27.7% of respondents for ADHD and 31.6% for ASD. Routine monitoring refers to always or usually monitoring after supplementation.

Table 6 shows the supplementation recommendation patterns and post-supplementation monitoring practices of children with ADHD and ASD by dietitians. Both ADHD (35.9%) and ASD (37.4%) were more likely to be recommended for supplementation "sometimes" than in comparison to routine recommendations, which were 27.7% for ADHD and 31.6% for ASD. 43.6% of respondents reported that they always or usually monitored outcomes after the supplementations, compared to 34.5% who sometimes monitored. The results indicate that supplementation is not routinely used and monitoring is not consistent between dietitians.

Table 7: Perceived Barriers to Effective Nutritional Management of Children With ADHD and ASD

Barrier	M	SD
Insufficient training in neurodevelopmental nutrition	4.38	0.74
Limited consultation time per patient	4.22	0.81
Lack of locally relevant clinical guidelines	4.18	0.86
Poor caregiver adherence to dietary recommendations	4.06	0.92
Inadequate access to validated assessment tools	3.94	0.88

Barrier	M	SD
Cultural barriers affecting dietary advice uptake	3.86	0.96
Insufficient evidence base for clinical decisions	3.78	0.94
Lack of funding/resources for supplements	3.72	1.02
Limited MDT referral pathways	3.68	0.98
Language and health literacy barriers in families	3.54	1.06
Child behavioral challenges during consultations	3.42	1.08

Note. *Ratings were measured on a 5-point Likert scale ranging from 1 (Not a barrier) to 5 (Major barrier).* M = *mean;* SD = *standard deviation; MDT = multidisciplinary team.*

Table 7 shows the dietitians' perceived barriers that may hinder them in managing the nutrition of children with ADHD and ASD effectively. The barriers with the highest ratings were limited consultation time (M = 4.22, SD = 0.81), lack of locally relevant clinical guidelines (M = 4.18, SD = 0.86) and insufficient training in neurodevelopmental nutrition (M = 4.38, SD = 0.74). Low caregiver adherence to dietary recommendations also was viewed as a significant challenge (M = 4.06, SD = 0.92). The results suggest that systemic factors, such as lack of training, and family-specific factors, such as caregiver adherence, cultural influences and health literacy, also pose substantial challenges in providing evidence-based nutrition care to children with ADHD and ASD.

Table 8 : ***Caregiver Engagement Strategies and Follow-Up Practices Used by Dietitians***

Variable	Category	n	%
Caregiver education strategies	Verbal counselling during consultation	378	91.7
	Written meal plans and dietary guides	248	60.2
	WhatsApp/SMS follow-up messages	224	54.4
	Visual aids/picture food guides	112	27.2
	Referral to reputable online resources	96	23.3
	Group caregiver education sessions	48	11.7
	Demonstration sessions for food preparation	36	8.7
	No formal caregiver education provided	62	15.0

Variable	Category	n	%
Follow-up frequency	Yes, routinely for all patients	78	18.9
	Yes, for complex cases only	186	45.1
	Rarely	112	27.2
	No	36	8.7

Note. Respondents could select multiple education strategies. Routine follow-up for all patients was reported by 18.9% of respondents.

Table 8 shows dietitians' strategies and follow-up practices in nutritional management of children with ADHD and ASD. The most frequently used strategies were verbal counselling (91.7%), written meal plans and dietary guides (60.2%) and WhatsApp/SMS follow-up messages (54.4%). Some other less common strategies involved group caregiver education sessions (11.7%) and food preparation demonstration (8.7%). Regarding follow up, the majority of dietitians reported follow up only for complex cases (45.1%) and 18.9% reported that routine follow up is provided for all cases. In summary, the results indicate that caregiver involvement is predominantly provided in direct counselling and written guidance, while structured follow-up and education through practical demonstration are limited.

Table 9: Dietitians' Attitudes Toward Emerging Nutritional Approaches for ADHD and ASD

Statement	M	SD
The gut microbiome meaningfully impacts ASD symptom severity	3.74	0.88
The gut microbiome meaningfully impacts ADHD symptom severity	3.62	0.94
I am open to recommending probiotic therapy for children with ASD	3.48	1.02
I routinely enquire about complementary/alternative therapies used by families	3.22	1.08
The GFCF diet produces clinically significant improvements in ASD symptoms	3.18	1.06
I am aware of nutrient-medication interactions in ADHD pharmacotherapy	3.06	1.12
Camel milk consumption benefits children with ASD	2.94	1.18
The ketogenic diet has a role in ASD management	2.86	1.14

Table 9 highlights the attitudes of dietitians towards new approaches to nutrition for children with ADHD and ASD. Respondents expressed the greatest agreement with the gut microbiome in relation to the severity of symptoms in ASD (M = 3.74, SD = 0.88) and ADHD (M = 3.62, SD =

0.94). Moderate consensus also existed regarding willingness to probiotic treatment for ASD (M = 3.48, SD = 1.02). However, the level of agreement was lower for the camel milk consumption (M = 2.94, SD = 1.18) and the ketogenic diet for ASD (M = 2.86, SD = 1.14). Overall, the results indicated that dietitians are reasonably accepting of the microbiome approach and are more hesitant to recommend new interventions, like camel milk and ketogenic diet.

Discussion

The current study revealed average knowledge levels among dietitians in the nutrition management of children with ADHD and ASD. The knowledge was relatively high in micronutrient deficiency while lower scores were seen in concepts of gut–brain axis and supplementation practice. The pattern indicates that dietitians have a more understanding of traditional nutrition issues than they do of the new fields of neurodevelopmental nutrition. The importance of iron, zinc, magnesium, vitamin D and omega-3 fatty acids has also been previously demonstrated in ADHD and ASD and has been pointed out that it is very important to use a careful clinical interpretation when recommending a supplementation (Adams et al., 2011; Kotsi et al., 2019; Robberecht et al., 2020).

There were statistically significant differences in knowledge scores based on qualification level and years in practice. The knowledge scores for both ADHD and ASD were highest among dietitians who have more years of postgraduate education and clinical experience. This finding indicates that advanced academic training and practical clinical exposure may contribute to improved understanding of nutrition-related issues in neurodevelopmental disorders. The results of this study are consistent with those noted in the literature, in which limited formal training and lack of professional development were cited as key barriers for evidence-based nutrition care for autistic children as well as children with neurodevelopmental needs (Blaine et al., 2023; Conti et al., 2023).

The main approaches used for clinical assessment were traditional ones such as 24-hour dietary recall, FFQ, anthropometric measurements and simple lab tests. The application of validated feeding behaviour screening instruments, however, was relatively underused as well as fatty acid profiling and gut microbiome or stool analysis. This is clinically relevant, as children with ASD often exhibit food selectivity, sensory feeding problems, and gastrointestinal symptoms which necessitate condition-specific and structured assessment (Cermak et al., 2010; Esposito et al., 2023; Sharp et al., 2019).

The most frequently recommended dietary changes for ADHD were cutting back on refined sugar, processed foods, and artificial food colors/food additives, and eating regular meals. Dietitians were more likely to counsel for diet modification and gluten-free/casein-free diets for ASD. Moderate was reported for the supplementation with omega-3 fatty acid, iron, zinc, magnesium and probiotics. The results indicate an emphasis by dietitians on the more pragmatic dietary regulatory strategies, and more specific interventions are chosen selectively. Such strategy aligns with emerging evidence of the need for personalized dietary approaches, which are based on clinical assessment and feeding habits, as well as the caregiver's capacity to feed the child, instead of universal dietary restriction or supplementation (Granero et al., 2021; Karhu et al., 2020; Pelsser et al., 2011; Piwowarczyk et al., 2018).

Supplementation practices also revealed important clinical variation. While there was a consensus in the literature that supplementation should be recommended, there was less consensus on routine post-supplementation monitoring. This discovery suggests that there may be a need for better follow-up care, with the risk of ineffective clinical results and over- or inappropriate use if supplementation is not monitored. Ideally, evidence-based supplementation should be influenced by the dietary assessment, biochemical markers, symptom profile and periodic follow-up evaluation.

The top barriers to effective nutritional management included inadequate training in neurodevelopmental nutrition, limited

consultation time, lack of locally relevant clinical guidelines, and poor adherence of the caregiver. These barriers include both professional and systemic barriers. Limited multidisciplinary services, lack of specialized pediatric dietitians, poor health literacy among caregivers and lack of national guidelines could limit the delivery of evidence-based nutritional care routinely in the Pakistani context (Imran et al., 2020). Hence, it is strongly recommended to develop Pakistan specific clinical guidelines and structured training programmes.

The primary form of caregiving engagement was verbal counselling, meal plans, and follow-up via WhatsApp and SMS. However, caregiver education sessions were less common and so were food preparation demos, as well as follow-up for all patients. Given that dietary management of ADHD and ASD is reliant on the caregiver's ability to do this at home, enhancing the counselling and follow-up system for caregivers in the family could enhance adherence and long-term outcomes.

Dietitians demonstrated moderate consensus on emerging methods, mainly with the gut microbiome and probiotics in ASD. But with camel milk and ketogenic diets, there was less agreement, a professional caution is warranted in their use. The results generally suggest that dietitians are willing to welcome new nutrition practices, but with a degree of circumspection when implementing them in their daily work.

To conclude, the findings of this study indicate that nutrition knowledge among dietitians in Pakistan about ADHD and ASD is present, and their practice is hampered by limited specialized knowledge, clinical guidelines, assessment tools, monitoring of nutrition supplementation and multidisciplinary collaboration. Professional training, local development of evidence-based protocols, and system strengthening of caregiver-focused nutrition support may be beneficial to the quality of nutritional support for children with ADHD and ASD.

Summary

This study aimed to assess dietitians' knowledge, clinical practices, dietary recommendations, barriers, caregiver involvement and attitudes regarding the nutritional management of children with ADHD and ASD. The results indicated that dietitians' knowledge of the diet was moderate, and their knowledge of micronutrient deficiencies was higher than gut–brain axis and supplementation practices. The scores for knowledge were significantly related to higher qualifications and years of professional experience.

24-hour dietary recall, anthropometric measurements, and simple laboratory tests were common dietary assessment methods, whereas specialized feeding assessment tools were used with fewer people. The top three recommended treatments for ADHD were: limiting refined sugar, setting regular meal times and avoiding artificial additives. For ASD, diets were more commonly recommended to be gluten-free/casein-free and have food texture modification.

Supplementation was applied where appropriate but monitoring of post-supplementation was inconsistent. Lack of training, limited consultation time, absence of local guidelines and non-compliance by caregivers were the main challenges. The primary approaches used to educate the caregivers were verbal counselling, written meal plans and electronic follow-up. Conclusively, the study suggests the need for specialized training, providing guidance for Pakistan specific nutritional care of children with ADHD and ASD, the collaboration of multi-disciplinary teams and adequate support from caregivers.

Recommendations

Based on the findings of this study, the following recommendations are proposed:

1. **Strengthen professional training in neurodevelopmental nutrition.** The education institutions, professional associations of dietitians, and healthcare institutions need to create courses on the evidence-based nutritional management of ADHD and ASD, such as micronutrient assessment, feeding disorders, gut–brain interactions, and nutrition supplementation practices, as well as provide these courses to their students.

2. **Develop Pakistan-specific clinical practice guidelines.** The national nutrition and paediatric professional bodies should work together to create a set of evidence-based guidelines that are applicable to the local healthcare environment and dietary habits for the nutritional assessment and management of children with ADHD and ASD.
3. **Promote multidisciplinary team (MDT) collaboration.** There should be regular incorporation of dietitians into multidisciplinary teams with pediatricians, child psychiatrists, neurologists, psychologists, speech-language pathologists, and occupational therapists, to provide comprehensive and coordinated care.
4. **Standardize nutritional assessment protocols.** Healthcare facilities should promote the regular application of existing validated tools for diet assessment, anthropometric monitoring, feeding behaviour screening and suitable biochemical investigations to enhance the accuracy of diet assessment and intervention planning.
5. **Implement evidence-based supplementation practices.** Only nutritional supplements should be indicated based on clinical assessment, nutritional evaluation, and laboratory testing. It is important to have regular follow-up and monitoring of treatment to assess its effectiveness and to avoid unnecessary supplementation.
6. **Enhance caregiver education and follow-up services.** To enhance adherence to dietary recommendations and long-term nutritional outcomes, dietitians should deliver caregiver education that is structured, involve providing written meal plans, using culturally relevant educational material, and offer regularly scheduled follow-up consultations.
7. **Improve access to clinical resources.** Healthcare institutions should make validated nutritional assessment tools and patient education materials more readily available, and set up a referral system to assist in evidence-based practice, especially at public-sector healthcare institutions.
8. **Support future research in Pakistan.** Further evaluation of the effectiveness of dietary interventions, supplementation strategies and caregiver education for children with ADHD and ASD among Pakistanis is required through longitudinal studies, randomized controlled trials, and implementation studies.
9. **Incorporate neurodevelopmental nutrition into dietetics education.** Undergraduate and postgraduate dietetics curricula should include dedicated training on ADHD, ASD, feeding disorders, pediatric behavioral nutrition, and evidence-based dietary interventions to better prepare future dietitians for clinical practice.
10. **Increase awareness among healthcare professionals and families.** Nutrition awareness campaigns should highlight the complementary nature of the treatment of ADHD and ASD and underscore the need for a personalized approach to nutrition based on qualified health care professionals' guidance and not on untested or unconfirmed nutrition practices.

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