ORIGINAL ARTICLE

Human and Clinical Nutrition

An Observational Study on the Use of Manual Muscle Testing for Dietary Elimination in Food Sensitivity-Related Conditions

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ABSTRACT

Background: Adverse food reactions are a highly prevalent concern, manifesting in a diverse range of gastrointestinal, cutaneous, and, respiratory symptoms. The accurate determination of food sensitivity (FS) therefore of considerable importance in the effective management of associated symptomatology. Manual muscle testing (MMT), a non-invasive diagnostic technique, is employed to identify physiological imbalances or areas of tenderness by assessing muscular responsiveness. However, t utility of MMT in identifying food sensitivities has not been sufficiently investigated in the existing scientific literature.

Aims: The present study aimed to investigate the efficacy of an elimination diet, guided by MMT findings, in providing symptomatic relief for issues associated with food sensitivity.

Patients and Methods: Individuals with asthma, atopic dermatitis, dyspepsia, fibromyalgia, and low-back pain were enrolled in this study. Food sensitivities, to a panel of 81 food items were determined using MMT. A total of 152 participants were recruited, comprising, comprising 100 individuals assigned to the diet intervention group and 52 to the control group. Participants in the diet group adhered to an elimination diet for 30 days, formulated based on their individual MMT results. Outcome measures included the Short Form-36 Quality of Life Scale, along with disease-specific instruments administered via a face-to-face questionnaire: the Asthma Control Test, Dyspepsia Severity Scale, Patient-Oriented Eczema Measure, Quebec Low Back Disability Scale, and Revised Fibromyalgia Impact Questionnaire. Data were analyzed using SPSS version 27.

Results: A statistically significant improvement in Quality of Life (QoL) was observed in the intervention group following the dietary intervention ($p < 0.01$). The elimination diet improved scores across various disease-specific instruments: Asthma Control Test (from 13.6 ± 4.3 to 19.2 ± 4.3, $p < 0.01$), Patient-Oriented Eczema Measure (from 15.4 ± 7.4 to 5.0 ± 5.2, $p < 0.01$), Dyspepsia Severity Scale; Pain Intensity (from 22.6 ± 10.9 to 6.2 ± 10.7), Non-Pain Symptoms (from 18.7 ± 4.4 to 11.0 ± 4.3), and Satisfaction (from 11.7 ± 2.0 to 13.0 ± 1.6) ($p < 0.01$). Significant improvements were also noted in Revised Fibromyalgia Impact Questionnaire scores (from 55.1 ± 19.5 to 30.5 ± 19.5, $p<0.01$) and Quebec Low Back Disability Scale scores (from 19.2 ± 16.4 to 11.6 ± 9.6, $p < 0.01$).

Conclusions: The present study indicates that an elimination diet based on MMT results may contribute to the alleviation of food sensitivity-related symptoms. While MMT appears to be a promising method for identifying food sensitivities, further rigorous investigations are warranted to fully establish its diagnostic utility.

Keywords: Applied kinesiology; Manual muscle testing; Elimination diet; Nutrition; Food sensitivity.

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1 INTRODUCTION

Adverse reactions to foods (ARFs) encompass food allergies (FA) and food intolerances (FI), both of which adversely affect health (Soh *et al.*, 2015). Food allergy is precisely defined as an adverse health effect arising from a specific immune response that consistently recurs upon exposure to a particular food (Boyce *et al.*, 2011). Conversely, food intolerance refers to a non-immune-mediated adverse reaction to food, typically triggered by food components, nutrients, or nutritional additives (Patriarca *et al.*, 2009). The clinical manifestations of FA and FI often overlap, presenting with a spectrum of gastrointestinal, cutaneous, respiratory,

and neurological symptoms (Mahan, 2016). The term "food sensitivity" is a broader, nonspecific designation that can include any symptom perceived to be food-related, thus allowing for varied interpretation and usage (Lavine, 2012). It is commonly employed when the underlying mechanism of a reaction— whether immunologically or attributable to a biochemical or physiological defect—remains unclear (Joneja, 2013).

ARFs are implicated in the pathogenesis or exacerbation of numerous conditions, such as asthma and atopic dermatitis (AD), by affecting various organ systems (Foong et *al.*, 2017; Mastrorilli *et al.,* 2017; Pasqui *et al.,* 2015). Furthermore, emerging evidence suggests potential mechanisms linking ARFs to symptoms observed in fibromyalgia and even Low Back Pain (LBP) symptoms related to some form of ARFs (Niu *et al.,* 2019; Slim *et al.,* 2015). Individuals with food sensitivities or food allergies exhibit a higher incidence of asthma and AD compared to the general population. Studies indicates that approximately 20% of individuals with food allergy also have asthma, and food allergy is present in 30% to 40% of those with AD, a correlation particularly pronounced in childhood (Papapostolou *et al.,* 2022; Wang & Liu, 2011). While comprehensive prevalence outcomes regarding the relationship between dyspepsia, low back pain, fibromyalgia, and food sensitivities remain limited in the literature, existing studies suggest that nutrition-related mechanisms significantly influence symptom management. Specific nutrients may increase the severity of these conditions, and, in certain instances, targeted dietary interventions especially personalized elimination diets may alleviate symptoms (Niu *et al.,* 2019; Pesce *et al.,* 2020; Slim *et al.,* 2015). However, more extensive and long-term research is imperative to provide clear and definitive evidence for these associations. Several studies have also consistently reported that ARFs negatively affect an individual's quality of life (QoL) (Antolín-Amérigo et *al.*, 2016).

Changes in the modern diet and environmental factors interacting with genetic predisposition led to increased ARFs, which parallels the rise in chronic diseases. Adverse responses to foods affect approximately 5% of young children and 3 to 4% of adults in Westernized countries and their prevalence appear to be increasing (Sicherer & Sampson, 2010). Furthermore, over 220 million individuals worldwide are estimated to suffer from some form of FA, though the reported figures are likely an underestimate. Considering all these circumstances, the accurate determination of ARFs is of paramount importance (Muraro *et al.,* 2014).

Various diagnostic methods are employed to determine ARFs; some are widely accepted and evidence-based, while others lack robust scientific validation (Mullin *et al.,* 2010). Established, evidence-based procedures currently utilized for patients with suspected food reactions include serum immunoglobulin tests, skin prick tests, atopy patch tests, elimination diets (ED), and oral food challenges (Beyer & Teuber, 2005; Kelso, 2018; Mullin *et al.,* 2010; Sampson, 1999). Conversely, certain approaches adopted by practitioners as alternative or complementary therapies in the detection of food allergies are widely used but are considered unproven methods in the scientific literature. These methods include specific IgG testing, provocation/neutralization testing, cytotoxic testing, electrodermal testing and applied kinesiology (AK)(Beyer & Teuber, 2005; Jensen, 2015; Kelso, 2018).

AK is a diagnostic system that assesses normal and abnormal physiological functions, integrating various mainstream, complementary, and alternative therapeutics. AK facilitates the assessment of muscle function and neuromuscular imbalances by evaluating muscle strength in response to specific stimuli. This technique aims to identify disruptions in the body's neurophysiological balance, such as altered nerve conduction, muscular weakness, or aberrant reflex responses. Practitioners of AK utilize these muscle responses to guide diagnosis and inform therapeutic interventions aimed at correcting these imbalances. Within the scope of AK, Manual Muscle Testing (MMT) is a technique for identifying neurophysiological imbalances by assessing the strength and function of muscles. By examining muscle responses, this test attempts to detect muscle weaknesses that may correlate with organ dysfunction, food intolerances, stress, or other pathological conditions. In AK practice, muscle weakness is considered an indicator of functional disorders within a particular organ or system (Cuthbert & Goodheart Jr, 2007). MMT is a non-invasive assessment tool utilized by various health care providers, including physiotherapists, chiropractors, osteopaths, and medical doctors, for various evaluations of neuromusculoskeletal integrity (Jensen, 2015). The method is also claimed to be capable of allergen testing: when a patient holds a suspected allergen, a decrease in muscular strength is claimed to occur if the substance possesses adverse potential. This rationale forms the basis for testing patients for food sensitivities (Ernst & Hentschel, 1995).

To the best of our knowledge, there is limited data in the scientific literature regarding the application of AK and MMT in context of food sensitivities. Therefore, this study aimed to evaluate the effect of an elimination diet, guided by MMT-derived food sensitivity results, on symptomatic relief in individuals presenting with asthma, atopic dermatitis, dyspepsia, fibromyalgia, and low back pain. By examining these aspects, we sought to gain a deeper understanding of how an MKT-based elimination diet might serve as an effective tool for diagnosing and managing food sensitivities in individuals with food sensitivity related diseases. The findings from this study may offer valuable insights into the

potential of MKT-based elimination diets as a method for managing food-related health issues.

2 Material and Methods

2.1 Study Design and Population

This prospective study was conducted at Istanbul Medipol University to investigate the effects of Manual Muscle Testing (MMT) in determining food sensitivities. Inclusion criteria for participation were: individuals aged 16–70 years, admission to the Istanbul Medipol University Internal Medicine outpatient clinic, a confirmed diagnosis of asthma, AD, dyspepsia, fibromyalgia, or LBP, and symptom persistence for a minimum of one month. To be enrolled, participants were required to be capable of providing the requisite information for food sensitivity determination in accordance with the study's objectives and to voluntarily provide informed consent. These criteria were established to ensure the recruitment of a homogeneous and valid patient population. Exclusion criteria comprised patients receiving immunosuppressive drugs or systemic corticosteroids, individuals with active infections or acute medical conditions, pregnant or lactating women, individuals with diagnosed psychiatric illnesses, and patients exhibiting malnutrition.

Participants were recruited using a quota sampling methodology. The intervention group comprised 100 patients who adhered to a 30-day elimination diet, while 52 patients maintaining their usual dietary habits constituted the control group.

The study protocol underwent rigorous review and received approval from the Istanbul Medipol University Non-Interventional Ethics Committee (reference number 10840098-604.01.01.-E.53716, issued on December 21, 2018). This trial was conducted in strict compliance with the ethical principles outlined in the Declaration of Helsinki. Individuals who voluntarily agreed to participate provided their signed 'Minimum Informed Voluntary Consent Form'.

2.2 Determination of Food Sensitivity

The MMT method described by Jensen (2015), was employed to determining the food sensitivities of the patients. MMT in kinesiology typically involves applying resistance to a specific muscle group while the participant maintains a specific posture or executes a particular movement. The examiner assesses muscular strength and weakness by applying an opposing force and assessing how the individual's ability to resist this force. The procedure typically commences with the participant in a relaxed state, followed by the application of gentle pressure to the target muscle or muscle group. A standard muscle is initially tested to establish a baseline, after which other muscles or muscle groups are assessed to identify imbalances or deficits. Assessment of weakness in the contralateral arm (the arm opposite to the one being tested), a common technique in Applied Kinesiology, involves comparing the resistance while the other arm is assessed for its response to the identical resistance. This involves comparing the strength or weakness of the contralateral arm by testing both arms in parallel to detect any significant differences in muscle response. If a person's contralateral arm is weaker or demonstrates less resistance than the target muscle or side, it may indicate an imbalance, which is relevant for diagnosing conditions related to muscle weaknesses or food sensitivities, (Ernst & Hentschel, 1995; Jensen, 2015; Kelso, 2018). Utilizing MMT, sensitivities to 81 distinct food components were examined, categorized as follows: cereals (n=15), legumes (n=4), fish (n=9), milk (n=3), meat (n=5), vegetables (n=9), stimulants (n=5), fruits (n=14), nuts (n=6), spices (n=15), teas (n=6) and oils (n=2).

2.3 Elimination Diet Management and Compliance Monitoring

In the dietary intervention group, food sensitivities, as identified by MMT results, were systematically eliminated from the diet for a period of 30 days. Following the MMT, each participant received clear, individualized instructions outlining prohibited and permitted food items. The elimination diet was meticulously customized to each participant's unique sensitivities, current health status, and presenting symptoms. To support adherence and ensure proper management of the elimination diet, a personalized and proactive communication strategy was implemented. Prior to the commencement of the dietary intervention, participants were thoroughly informed about the food groups to be eliminated and were offered guidance on appropriate dietary alternatives to maintain dietary balance. Throughout the 30–day period, participants were contacted telephonically at regular intervals — with a minimum frequency of once every two weeks—. These check-ins facilitated compliance monitoring, addressing emerging challenges or inquiries, and providing further guidance as required. In addition, participants were encouraged to initiate contact as needed, thereby fostering a bidirectional and responsive support system. Importantly, individuals who demonstrated non-compliance with the elimination diet protocol were excluded from the final analysis to preserve the integrity and validity of the dietary intervention group. Participants in the control group were instructed to maintain their habitual dietary patterns and to abstain from any dietary modifications throughout the study period.

2.4 Anthropometric Measurements

Anthropometric measurements, including body weight (BW), height, body mass index (BMI), body composition (BC), waist circumference (WC), hip circumference (HC),

and waist-to-hip ratio (WHR), were conducted both prior to and following the elimination diet (ED). Height was measured using a stadiometer, with participants standing erect, feet together, and the head positioned in the Frankfort plane. Body weight and BC (comprising fat, lean mass, and total body water) were determined using the Inbody 370 device via Bioelectrical Impedance Analysis (BIA) (Casadei & Kiel, 2024).

Measurements were conducted in the morning, with participants in a fasted state (following a minimum of eight hours of fasting), lightly clothed and free of metallic objects. Participants were instructed to abstain from vigorous exercise and ensure adequate hydration prior to measurement. During the measurement, participants stood upright, making bare foot contact with the device's electrodes. Parameters including body weight (kg), height (cm), body mass index (BMI, kg/m²), body fat percentage (%), lean body mass (kg), and total body water percentage (%) were acquired through the BIA device (Casadei & Kiel, 2024).

All anthropometric measurements adhered to standardized protocols. Height was measured using a stadiometer, with participants in a standing position and the head aligned in the Frankfurt plane. Body weight was determined using a calibrated electronic scale. To minimize measurement error, all measurements were performed by the same trained individual under standard conditions. Waist circumference was measured employing a flexible, non-elastic tape at the narrowest point between the inferior costal margin and the superior border of the iliac crest, with the participant in an upright stance. During this measurement, abdominal muscles were relaxed, and respiration remained normal. Hip circumference was measured at the widest gluteal protrusion, with the participant standing upright and the tape measure positioned parallel to the floor. All measurements were consistently performed by the same individual in the morning, with minimal clothing and direct skin contact where feasible. To ensure accuracy, each measurement was replicated at least twice, and consistent readings were recorded (Casadei & Kiel, 2024).

2.5 Disease Symptom Scales

The Short Form (SF)-36 Quality of Life (QoL) Scale was administered to all participants both prior and following the elimination diet. The SF-36 QoL scale comprises eight sub-categories: Emotional Role (ER), General Health (GH), Mental Health (MH), Pain (P), Physical Function (PF), Physical Role (PR), Social Function (SoF), and Vitality (V) (Hays *et al.*, 2002). In accordance with the participants' diagnoses, the following disease-specific instruments were also administered at baseline and after the 30-day intervention: Asthma Control Test (ACT) (Nathan *et al.*, 2004), Fibromyalgia Impact Questionnaire (FIQ)(Bennett, 2005), Patient-Oriented Eczema Measure (POEM)(Charman *et al.*, 2004), Dyspepsia Severity Scale (SODA)(Rabeneck *et al.*, 2001), and / or Quebec Low Back Pain Disability Scale (QLBPDS) (Kopec *et al.*, 1996).

2.5.1 SF-36 Quality of Life Scale

The SF-36 Quality of Life Scale is a self-assessment instrument originally developed by Ware *et al.*, (1992), with its validity and reliability rigorously conducted by Hays *et al.*, (2002). This scale consists of 36 items designed to assess health-related quality of life across eight distinct dimensions: physical function, physical role, general health, vitality, pain, mental health, social function and emotional role. Higher scores on the SF–36 indicate superior health status, whereas lower scores reflect a deterioration in health.

The scoring methodology defines the "expected possible lowest score" as the minimum achievable score from the relevant questions, the "expected possible highest score" as the maximum achievable score, and the "possible raw score range" as the difference between these highest and lowest scores for the respective questions (Hays *et al.*, 2002).

2.5.2 Asthma Control Test (ACT)

The Asthma Control Test (ACT) was developed by Nathan *et al.*, in (2004) to provide a multidimensional assessment of asthma control in patients aged 12 years and older. Its design prioritizes suitability for use in both primary and secondary care settings, sensitivity to clinical changes, ease and speed of administration, straightforward evaluation, and user-friendliness for patients. The test evaluates asthma control based on the frequency of daytime and nighttime symptoms, the need for rescue medication, dyspnea frequency, and the patient's self-assessment of their asthma control. For each of the five questions, patients assign a score ranging between 0 and 5, reflecting the severity of their condition. The sum of these five question scores constitutes the total test result. A total score of 25 signifies complete asthma control, a score between 20 and 24 indicates partial control, and a score of ≤ 19 suggests uncontrolled asthma (Nathan *et al.*, 2004).

2.5.3 Fibromyalgia Impact Questionnaire (FIQ)

The Fibromyalgia Impact Questionnaire (FIQ) is a a widely utilized instrument for assessing health status and functional impairment in individuals with fibromyalgia. Originally developed by Burckhardt *et al.* in 1991, it was subsequently revised by Bennett (2005). The FIQ consists comprises 21 questions into three sections: 'Function' (9

questions), 'General' (2 questions), and 'Symptoms' (10 questions). For scoring, the raw scores from each of the three sections are summed. The score for Section 1 is then divided by 3, the score for Section 2 by 1, and the sum for section 3 by 2. The final questionnaire score is obtained by summing these adjusted section scores (Bennett, 2005).

2.5.4 Patient-Oriented Eczema Measure (POEM)

The Patient-Oriented Eczema Measure (POEM) scoring system was introduced by Charman *et al.*, in 2004. This system is designed to capture the patients' perspectives on disease severity. Both pediatric and adult respond to simple questions regarding the frequency of seven key symptoms: itching, sleep disturbances, skin bleeding, skin watering, skin cracking, scaling, and skin dryness/coarsening. The POEM score is calculated based on the number of days per week these symptoms occur. A score of 0 is assigned for symptoms never occurring, 1 point for occurring 1-2 times per week, 2 points for 3–4 days, 3 points for 5–6 days, and 4 points for occurring every day. The scale encompassing these seven symptoms, yields a total score ranging from 0 to 28 points (Charman *et al.*, 2004).

2.5.5 Dyspepsia Severity Scale (SODA)

The Severity of Dyspepsia Scale (SODA) is a disease-specific instrument developed by Rabeneck *et al.* (2001) for the primary assessment of health outcomes in dyspepsia. The scale consists of three distinct subscales: Pain Intensity (6 items), Non-Pain Symptoms (7 items), and Satisfaction (4 items). In the Pain Intensity subscale, scores range from 2 to 47, where 2 indicates the lowest pain intensity and 47 reflects the highest. The Non-Pain Symptoms subscale evaluates symptoms such as heartburn, burning sensations, bloating, gas, and nausea with scores ranging from 7–35. A score of 7 reflects no issues with non-pain symptoms, while a score of 35 indicates severe disturbance from these symptoms. The third subscale assesses patient satisfaction with their discomfort, with scores ranging from 2 to 23. A score of 2 reflects very low satisfaction, while 23 indicates the highest level of satisfaction (Rabeneck *et al.*, 2001).

2.5.6 Quebec Low Back Pain Disability Scale (QLBPDS)

The Quebec Low Back Pain Disability Scale was developed by Kopec *et al.* in (1996) to assess functional status in patients experiencing low back pain. The concepts integrated into the scale align with the World Health Organization's concept of disability. The scale consists of 20 questions that quantify the patient's level of physical functioning. Each question is scored on a scale from 0 (not difficult at all) to 5 (impossible to do). The cumulative score ranges from 0 (indicating no dysfunction) to 100 (representing maximum dysfunction) (Kopec *et al.*, 1996).

2.6 Statistical Analysis

Categorical variables were compared using the Chi-square test. In instances where expected frequencies were less than five, Fisher's Exact test was applied. Normality of data distribution was evaluated using the Shapiro-Wilk test for sample sizes below 50 and the Kolmogorov-Smirnov test for sample sizes of 50 or more.

For the comparison of two time-point measurements within dependent groups, appropriate statistical tests were applied based on the distribution of the data. The Paired Sample *t*-Test was used for normally distributed variables, while the Wilcoxon Signed-Rank Test was used for non-normally distributed variables. For the comparison of independent groups, statistical tests were selected based on the distribution of the data. The Independent Samples t-Test was used for normally distributed variables, whereas the Mann-Whitney U Test was applied for non-normally distributed variables. A p-value of < 0.05 was considered statistically significant. All statistical analyses were performed using the SPSS v27 software package (IBM Inc., Chicago, IL, USA)".

3 Results

3.1 Characteristics of the Study Participants

A total of 152 patients were enrolled in the study, with 100 assigned to the diet intervention group and 52 to the control group. Both cohorts comprised individuals diagnosed with asthma, AD, dyspepsia, fibromyalgia, and LBP. The demographic characteristics of participants are presented in Table 1.

Anthropometric measurements of participants, recorded at baseline and following the 30-day elimination diet, including BW, BMI, body fat percentage, WC, and a significant decrease in BW, BMI, body fat percentage, lean body mass, body water, WC, HC, and WC/HC are detailed in Table 2. A statistically significant decrease was observed in BW, BMI, body fat, WC, and HC within diet intervention groups ($p < 0.05$). Conversely, no differences were observed in the anthropometric measurements of the control group ($p > 0.05$).

The scores from the SF-36 Quality of Life scale scores, including physical function, social function, physical role, emotional role, mental health, vitality, pain, and general health, are presented in Table 3. At the baseline of the study, no significant differences were observed between the groups in QoL scores ($p > 0.05$). Following the diet intervention, a

Table 1. The demographic characteristics of the study groups

	Sex							Age							
	Diet Intervention			Control			Differences Between Groups	Diet Intervention			Control				Differences Between Groups
	n	F (%)	M (%)	n	F (%)	M (%)	*p*-value	min	max	Mean ± SD	n	min	max	Mean ± SD	*p*-value
Total	100	85	15	52	87.5	12.5	0.557 [a]	19	70	41.2 ± 11.3	40	22	70	39.8 ± 13.0	0.11 [c]
Asthma	20	80	20	8	75	25	0.568 [b]	19	70	44.0 ± 14.0	8	22	70	48.1 ± 18.2	0.23 [d]
AD	20	75	25	8	87.5	12.5	0.432 [b]	20	61	38.7 ± 12.0	8	25	46	34.2 ± 7.9	0.16 [d]
Dyspepsia	20	90	10	20	85	15	0.50 [b]	24	59	44.3 ± 9.9	20	22	55	36,5 ± 8,9	0.77 [d]
Fibromyalgia	20	100	0	8	100	0	n.d.	19	55	38.8 ± 10.0	8	28	70	38.1 ± 13.7	0.57 [c]
LBP	20	80	20	8	100	0	0.237 [b]	26	60	40.5 ± 9.6	8	25	61	37.1 ± 12.0	0.77 [d]

Note: AD: Athopic Dermatit; LBP: Low Back Pain; F: Female; M: Male. [a] Chi-square test, [b] Fisher's Exact Test, [c] Mann-Whitney U test, Independent Samples t test, n.d. (not determined due to absence of male participants in group.

Table 2. Anthropometric measurements of patients at the baseline and one-month post-intervention (mean ± SD)

	Diet Intervention (n=100)			Control Group (n=52)			Differences Between Groups	
	Baseline	One month	*p*-value	Baseline	One month	*p*-value	Baseline *p*-value	One month *p*-value
Body Weight (kg)	74.2 ± 15.9	73.2 ± 14.5	< 0.01 [a]	72.0 ± 17.6	72.3 ± 17.3	0.22 [a]	0.11 [b]	0.25 [b]
BMI (kg/m²)	26.9 ± 5.6	26.6 ± 5.6	< 0.01 [a]	26.9 ± 7.1	26.9 ± 7.0	0.76 [a]	0.30 [b]	0.49 [b]
Body Fat (%)	33.3 ± 10.0	31.7 ± 9.3	< 0.05 [a]	32.9 ± 9.3	32.3 ± 9.6	0.27 [a]	0.28 [b]	0.81 [b]
Lean Body Mass (%)	13.2 ± 1.9	13.7 ± 4.2	0.29 [a]	13.2 ± 1.9	13.6 ± 4.7	0.41 [a]	0.68 [b]	0.86 [b]
Body Water (%)	49.5 ± 7.5	50.0 ± 7.6	0.052 [a]	53.1 ± 7.5	53.4 ± 7.4	0.26 [a]	0.01 [b]	0.01 [b]
Waist Circumference (cm)	85.1 ± 14.0	83.3 ± 13.1	< 0.01 [a]	83.8 ± 14.0	83.8 ± 13.8	0.91 [a]	0.45 [b]	0.79 [b]
Hip Circumference (cm)	106.0 ± 9.9	104.6 ± 9.7	< 0.01 [a]	103.6 ± 9.5	103.6 ± 9.3	0.93 [a]	0.02 [b]	0.25 [b]
Waist/Hip Circumference	0.80 ± 0.09	0.79 ± 0.09	0.27 [a]	0.80 ± 0.09	0.79 ± 0.09	0.27 [a]	0.54 [b]	0.21 [b]

Note: *BMI: Body Mass Index; [a] Wilcoxon Signed-Rank, [b] Mann-Whitney U test,

Table 3. SF-36 Quality of life score of patients at the baseline and one-month post-intervention (mean ± SD)

	Dietary Elimination			Control				
	Baseline	One month	*p*-value	Baseline	One month	*p*-value	Baseline *p*-value	One month *p*-value
Physical Function	65.8 ± 21.5	74.7 ± 19.9	< 0.01 [a]	61.6 ± 20.7	63.2 ± 17.4	0.50 [a]	0.40 [b]	0.01 [b]
Social Function	60.6 ± 25.1	79.7 ± 20.8	< 0.01 [a]	59.1 ± 25.3	60.3 ± 23.7	0.48 [a]	0.85 [b]	0.01 [b]
Physical Role	72.9 ± 21.5	86.2 ± 19.3	< 0.01 [a]	49.0 ± 36.2	52.1 ± 30.6	0.36 [a]	0.00 [b]	0.01 [b]
Emotional Role	73.7 ± 22.3	87.5 ± 18.0	< 0.01 [a]	56.1 ± 41.6	49.8 ± 36.5	0.13 [a]	0.01 [b]	0.01 [b]
Mental Health	64.4 ± 17.0	73.5 ± 17.2	< 0.01 [a]	65.5 ± 13.2	64.4 ± 12.1	0.40 [a]	0.73 [b]	0.01 [b]
Vitality	42.8 ± 20.1	57.5 ± 19.6	< 0.01 [a]	47.2 ± 17.5	48.4 ± 15.7	0.54 [a]	0.23 [b]	0.01 [b]
Pain	53.6 ± 19.1	64.1 ± 17.6	< 0.01 [a]	45.7 ± 9.3	46.1 ± 9.7	0.79 [a]	0.01 [b]	0.01 [b]
General Health	53.1 ± 19.2	61.9 ± 19.3	< 0.01 [a]	53.5 ± 16.2	53.0 ± 15.2	0.81 [a]	0.64 [b]	0.01 [b]

statistically significant improvement was noted across all sub-categories of QoL scores within the diet intervention group ($p < 0.05$), whereas no such modifications were evident in the control group ($p > 0.05$).

Disease symptom scores for patients, assessed at baseline and after the 30–day elimination diet, including ACT, SODA Pain Severity, FIQ, POEM, and QLBPDS, are provided in Table 4. Initially, the average disease symptom

scores were statistically comparable between the diet intervention group and the control group ($p > 0.05$). As illustrated in Table 4, the mean ACT score for asthma patients improved from 13.6 ± 4.3 at baseline to 19.2 ± 4.3 post-diet. Revised FIQ scores for patients with fibromyalgia decreased from 55.1 to 30.5 ($p < 0.01$). Similarly, the average POEM score averages for patients with AD decreased from 16.0 to 4.9 after the dietary intervention ($p < 0.01$). For dyspepsia patients, SODA Severity Scale scores for Pain Intensity, Non-Pain Symptoms, and Satisfaction which were 22.6 ± 10.9, 18.7 ± 4.4, and 11.7 ± 2.0 at baseline, respectively, changed to 6.2 ± 10.7, 11.0 ± 4.3, and, 13.0 ± 1.6 respectively (all $p < 0.01$). QLBPDS score averages for patients with low back pain were 35.2 at baseline and 12.1 after the diet ($p < 0.01$). In summary, a statistically significant improvement in disease symptom scores was observed across all diet intervention groups following the dietary intervention ($p < 0.01$). The proportion of patients who responded positively to the elimination diet is presented in the Supplementary File.

Table 4. Symptom scores of diseases at baseline and one-month post-intervention (mean ± SD)

	Dietary Elimination				Control				Differences Between Groups	
		Baseline	One month			Baseline	One month		Baseline	One month
	n	Mean ± SD	Mean ± SD	*p*-value	n	Mean ± SD	Mean ± SD	*p*-value	*p*-value	*p*-value
ACT	20	13.6 ± 4.3	19.2 ± 4.3	< 0.01 [a]	8	15.0 ± 4.4	14.8 ± 3.8	0.86 [a]	0.97 [b]	0.39 [b]
FIQ	20	55.1 ± 19.5	30.5 ± 19.5	< 0.01 [a]	8	50.6 ± 14.6	51.4 ± 13.4	0.60 [a]	0.40 [b]	0.45 [b]
POEM	20	15.4 ± 7.4	5.0 ± 5.2	< 0.01 [c]	8	14.5 ± 4.6	15.0 ± 5.3	0.51 [a]	0.20 [b]	0.74 [d]
SODA Severity Scale	20				20					
- Pain Intensity		22.6 ± 10.9	6.2 ± 10.7	< 0.01 [a]		18.2 ± 10.6	17.3 ± 9.6	0.053 [c]	0.68 [d]	0.01 [b]
- Non-Pain Symptoms		18.7 ± 4.4	11.0 ± 4.3	< 0.01 [a]		18.7 ± 5.1	17.2 ± 6.2	0.058 [c]	0.13 [d]	0.01 [d]
- Satisfaction		11.7 ± 2.0	13.0 ± 1.6	< 0.01 [c]		11.8 ± 1.8	12.6 ± 5.3	0.83 [c]	0.49 [d]	0.13 [b]
QBPDS	20	19.2 ± 16.4	11.6 ± 9.6	< 0.01 [c]	8	26.0 ± 17.1	26.7 ± 17.3	0.31 [c]	0.19 [b]	0.01 [d]

Note: ACT: Asthma control test, FIQ: Fibromyalgia Impact Questionnaire, POEM: Patient-Oriented Eczema Measure, Quebec Back Pain Disability Scale, ED: elimination diet. [a] Paired sample *t*-test, [b] Independent sample *t*-test, [c] Wilcoxon Signed-Rank, [d] Mann-Whitney U test

The food sensitivity results, determined by Manual Muscle Testing (MMT) responses, are detailed in the Supplementary File. Sensitivity to wheat, gluten, yeast, cow milk, beef, bovine meat, bean, tomato, onion, egg, olive oil, and sunflower oil were identified as the most prevalent among all study participants.

4 Discussion

MMT is a widely utilized method by healthcare professionals worldwide for diverse diagnostic and therapeutic purposes. Jensen (2015) reported the existence of 79 techniques within AK, with approximately 120.000 AK practitioners worldwide, and over 1.000.000 individuals trained in its application. However, the diagnostic validity of MMT remains a contentious issue in the scientific literature, and , with studies presenting divergent conclusions regarding its efficacy (Lüdtke *et al.*, 2001; Pothmann *et al.*, 2001; Schmitt & Leisman, 1998; Schwartz *et al.*, 2014; Staehle *et al.*, 2005). While MMT is claimed to be capable of identifying food sensitivities, research specifically investigating this application is exceedingly limited. For that purpose, the present study aimed to explore the utility of the AK MMT method in determining food sensitivity.

The food elimination diet is widely regarded as the gold standard for diagnosing food sensitivity (Yum *et al.*, 2011). In alignment with this principle, a 30–day elimination diet tailored based on MMT results, was implemented in the current study. As demonstrated in Table 1, the elimination diet led to a reduction in several anthropometric measurements. This observation may be attributed to a decreased energy intake resulting from the restricted food consumption inherent in an elimination diet. Consistent with our findings, previous studies employing elimination diets to manage food sensitivities management have identically reported decreases in anthropometric parameters (Atkinson *et al.*, 2004; Gubur, 2018; Neuendorf *et al.*, 2019).

Food sensitivities can significantly impair quality of life, often imposing limitations on social activities, necessitating dietary restrictions, and contributing to daily stress or anxiety (Warren *et al.*, 2020). According to results presented in Table 3, a statistically significant improvement in QoL was observed following the elimination diet, indicating a tangible benefit for the participating patients. In addition to all these, the outcomes detailed in Table 4 unequivocally demonstrate that an elimination diet guided by manual muscle testing was effective in managing symptoms associated with food sensitivity-related problems, including

asthma, AD, dyspepsia, fibromyalgia, and LBP. Previous research supports these findings; for instance, Virdee and Agarhedkar (2015) reported that food allergy elimination diets contribute to the prevention of asthma attacks (Agarkhedkar *et al.*, 2005; Virdee *et al.*, 2015). Similarly, elimination diets are widely employed in the treatment of AD and have been shown to improve symptoms (Roerdink *et al.*, 2016). Given that certain foods are known to trigger dyspepsia symptoms, dietary modifications are frequently utilized in symptom management Pesce *et al.* (2020). The current study's findings indicate that ED positively affected dyspepsia pain intensity, non-pain symptoms and overall patient satisfaction.

While the precise role of diet in fibromyalgia or LBP has not been fully elucidated, an underlying potential mechanism is hypothesized. Several studies investigating the effects of dietary interventions fibromyalgia treatment have concluded that nutrition may exert a significant impact (Marum *et al.*, 2016; Lukaczer *et al.*, 2000; Slim *et al.*, 2015; Smith *et al.*, 2001). The observed improvement in fibromyalgia scores in our study suggests that MMT could potentially be utilized to identify food sensitivities relevant to patients with fibromyalgia. Although LBP is not conventionally recognized to be directly associated with food sensitivities, pathophysiological mechanisms suggest that FA might play a role in the development of conditions such as ankylosing spondylitis (AS), which is a common cause of LBP. Limited studies have explored the relationship between AS and diet (Macfarlane *et al.*, 2018; Niu *et al.*, 2019; Sundström *et al.*, 2011). The improvement in LBP symptoms within our cohort may therefore indicate a hitherto unrecognized pathophysiological association between food sensitivity and LBP.

The food sensitivity results identified by MMT for the patients are provided in the Supplementary File. While elimination diets are essential in the management of food sensitivity-related symptoms, accurately determining which foods to eliminate is paramount to avoid the challenges associated with unnecessary dietary restrictions. The present study's findings indicate that sensitivities to foods such as wheat, gluten, milk, egg, bean, tomato, olive oil, and sunflower oil are commonly observed. However, these results also reveal that food sensitivities can vary considerably across different diseases and individual patients, thereby necessitating a personalized dietary approach. The present study suggest that an elimination diet based on MMT may offer a beneficial strategy for managing food sensitivity-related symptoms. Furthermore, MMT presents as a rapid, effortless, and cost-effective method. Nevertheless, the accuracy of AK MMT deserves further evaluation against other established diagnostic methods (e.g., serum immunoglobulin tests, skin prick tests, atopy patch tests) in future studies, though such comparative validation was beyond the scope of this investigation.

This study provides preliminary insights into the potential effects of an elimination diet guided by Manual Muscle Testing (MMT) on chronic symptoms and quality of life. However, this it is important to acknowledge several limitations. Firstly, the absence of randomization and blinding in the study design may introduce bias and consequently limit the internal validity of the findings. While concerted efforts were made to ensure standardized procedures and consistent communication with all participants, these methodological elements remain critical considerations for future research. Secondly, MMT is a non-standardized technique whose diagnostic validity has not yet been definitively evidenced. Although MMT served as a practical and accessible method to guide dietary interventions in this study, it was not complemented by other established diagnostic tools such as serum immunoglobulin analyses, skin prick tests, or patch tests, which are routinely employed in clinical allergy testing and atopic dermatitis management. The exclusion of these complementary tests was primarily due to budgetary and infrastructural constraints. Despite these limitations, the individualized dietary approach and continuous follow-up strategies implemented in this study offer valuable perspectives and demonstrate the feasibility of personalized dietary interventions in real-world clinical settings. These results thus lay foundational groundwork for future randomized and blinded trials that incorporate a multi-modal diagnostic approach to further validate and expand upon these findings.

5 Conclusions

Manual Muscle Testing (MMT) is an extensively method employed by health professionals for various clinical applications; however, its utility in determining food sensitivities has, to date, remained a subject of considerable controversy. The present study rigorously evaluated the efficacy of MMT in identifying food sensitivities by implementing an elimination diet for individuals afflicted with food sensitivity-related health conditions. The 30–day elimination diet, prescribed in accordance with MMT results, led to a statistically significant enhancement in quality of life and a notable alleviation of disease symptoms across a range of conditions, including asthma, AD, dyspepsia, fibromyalgia, and LBP.

Consequently, it can be concluded that MMT holds promise as a valuable tool for the identification of food sensitivity. Furthermore, MMT offers the advantages of being a rapid, straightforward, and cost-effective method, which could prove beneficial in the management of these

chronic conditions. Additionally, the findings underscore that targeted dietary modifications and food elimination strategies represent an effective therapeutic option for managing food sensitivity-related diseases. Future controlled studies, employing robust methodologies, are necessary to further validate the diagnostic accuracy and therapeutic implications of MMT in determining food sensitivity.

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