The Dual effect of Nutrition and Physical Activity on Low Back Pain: An Exploratory Study

Sakher Obaidat[1], Ahmed Hussein Mashaal[2], Ahmed Saad Shaban[2], Ahmad Muhsen[1], Mohamed Salah El-Sayed[3], Zainab Zueter[4], Suhad Abu auda[4], Abdulrahman Jamaan A Almalki[5]

1. Assistant Professor, Department of Physical and Occupational Therapy, Faculty of Applied Medical Sciences, Hashemite University, Jordan.
2. Assistant Professor, Physical Therapy Department, Faculty of Applied Medical Science, Irbid University, Jordan.
3. Lecturer, Department of Physical Therapy for Pediatrics, Faculty of Physical Therapy, Horus University-Egypt, New Damietta, Egypt.
4. Assistant Professor, Department of Nutrition and Dietetics, Faculty of Applied Medical Science, Irbid University, Jordan.
5. Physiotherapist, Eradah Complex and Mental Health, Taif, MOH, Taif, Saudi Arabia.

Abstract
Low back pain (LBP) remains a leading global cause of disability, yet traditional interventions often fail to address its multifactorial origins. This cross-sectional study explores the roles of nutrition and physical activity in mitigating LBP severity, integrating theoretical frameworks from the Health Belief Model (HBM) and Social Cognitive Theory (SCT). Data were collected from 120 diverse participants (aged 18–65) via structured questionnaires assessing demographics, pain intensity, dietary habits, and exercise behaviors. Results revealed a mean pain intensity score of 5.2 (±2.8 SD), with significant negative correlations between LBP severity and both nutritional interventions ($r = -0.28$, $p < 0.05$) and regular physical activity ($r = -0.35$, $p < 0.01$). Logistic regression highlighted stronger protective effects for physical activity ($\beta = -0.61$, $p < 0.001$) and nutrition ($\beta = -0.48$, $p = 0.003$), with a synergistic interaction term ($\beta = -0.33$, $p = 0.008$) underscoring enhanced benefits when combined. Notably, 45% of participants adopted dietary changes, while 62% engaged in regular exercise, primarily aerobic and strength training. The findings advocate for integrated lifestyle strategies in LBP management, emphasizing anti-inflammatory diets, low-impact exercise, and behavior-modification frameworks (HBM/SCT). Limitations include self-report bias and a youth-skewed sample, urging future longitudinal studies with objective measures. This study bridges theoretical and practical insights, offering a roadmap for holistic, patient-centered approaches to reduce the global burden of LBP.
Keywords: Low back pain, nutrition, physical activity, Health Belief Model, Social Cognitive Theory.

1. Background

Low back pain (LBP) is a leading cause of disability across much of the world, with nearly 80% of adults experiencing this condition at some point (Alzahrani et al., 2019). The etiology of LBP is complex and multifactorial, involving biomechanical, psychological, and lifestyle factors (Koes et al., 2010). Traditional approaches have relied on structural interventions, but emerging research suggests that these may be limited in their ability to prevent and manage the condition. Instead, modifiable risk factors such as diet and exercise show great promise in both preventing and treating LBP (Tatta et al., 2022; Foster et al., 2018). However, there is a gap in the research, specifically regarding the influence of nutritional and physical activity on pain-related outcomes. This study aims to fill this gap by exploring the relationships between these two modifiable factors and how they might complement traditional interventions for LBP.
Globally, LBP is responsible for 60 million disability-adjusted life years lost annually, with health

care costs of over $100 billion per year in the U.S. alone (Amorim et al., 2019; Dagenais et al., 2008). Unfortunately, despite its high prevalence, current therapies are still inadequate. Many studies suggest that treatment options heavily rely on pharmacological and surgical interventions that fail to address the root cause of the problem (Roren et al., 2023; Chou et al., 2017). Recent systematic reviews have shown that the relationship between physical activity and LBP is inconsistent (Sitthipornvorakul et al., 2010). Several research papers reported that sedentary lifestyle was associated with LBP, while a few found that high-intensity exercise could increase pain. Dietary studies are in their infancy, but anti-inflammatory diets and a high intake of micronutrients (for example, calcium, collagen) are showing promising results in reducing musculoskeletal breakdown (Visser et al., 2020; Giugliano et al., 2006).

The Health Belief Model (HBM) and Social Cognitive Theory (SCT) provide the backbone for understanding health behavior. In particular, HBM states that people take preventive measures (like changing diet) when they believe that LBP is a threat and that the intervention is successful (Sharafkhani et al., 2015). SCT, on the other hand, argues that self-efficacy (confidence in one's ability to engage in physical activity) predicts adherence to behavior (Shojaei et al., 2022; Bandura, 1997). This study will merge these theories to draw hypotheses about how nutrition and physical activity interact with psychological and physiological mechanisms to affect pain. This study builds on previous research by looking at a larger, more diverse sample size (n=120) and by incorporating nutritional and physical activity variables. It also attempts to fill gaps in literature, such as a lack of studies on combined lifestyle interventions (Geneen et al., 2017). This is being done to develop a more integrated, patient-centered approach to LBP management.

2. Research Design and Methods

2.1 Study Design

A cross-sectional design was employed to examine associations between nutrition, physical activity, and LBP. Data was collected via a structured questionnaire. The questionnaire comprised four sections:

- Demographics: Age, gender, occupation, LBP history.
- Pain Intensity: Self-reported on a 1–10 scale.
- Nutritional Habits: Dietary changes, supplement use (calcium/collagen), hydration, and calcium-rich food intake.
- Physical Activity: Type (aerobic, strength training), frequency, motivations, and perceived benefits.

2.2 Participants

The participant cohort of the research exhibits a notable level of diversity, covering individuals across a wide range of ages, from 18 to 65 years. Moreover, this cohort includes individuals from various vocations and lifestyles.

2.3 Data Analysis

Descriptive statistics summarize demographic and behavioral variables. Correlation analysis examined the relationships between LBP severity, nutrition, and physical activity. Logistic regression evaluated predictors of LBP incidence and severity. P value was set to <0.05. IBM SPSS v26 was utilized to analyze all data.

3. Results

The study included 120 participants with diverse demographic profiles (Table 1). The majority were aged 18–25 years (70%, n=84), followed by 26–40 years (20%, n=24) and >40 years (10%, n=12). Females constituted 58% (n=70) of the sample, while males represented 42% (n=50). Occupations included students (50%, n=60), office workers (30%, n=36), and manual laborers (20%, n=24). A significant proportion (68%, n=82) reported prior or current low back pain (LBP).

Table 1: Participant Demographics

Variable	Categories	Frequency	Percentage
Age	18–25	84	70%
	26–40	24	20%
	>40	12	10%
Gender	Female	70	58%
	Male	50	42%
Occupation	Student	60	50%
	Office Worker	36	30%
	Manual Laborer	24	20%
LBP	Yes	82	68%
	No	38	32%

Key behavioral and pain-related outcomes are summarized in Table 2:

- **Pain Intensity:** Participants reported a mean pain score of **5.2** (±2.8 SD) on a 1–10 scale.
- **Nutritional Habits:** 45% ($n=54$) modified their diets to address LBP, while 38% ($n=46$) used calcium or collagen supplements.
- **Physical Activity:** 62% ($n=74$) engaged in regular exercise, primarily aerobic (e.g., walking, swimming) and strength training.

Table 2: Descriptive Statistics

Variable	Mean	SD	Frequency	Percentage
Pain Intensity (1–10)	5.2	2.8	-	-
Dietary Changes (Yes)	-	-	54	45%
Supplement Use (Yes)	-	-	46	38%
Regular Physical Activity (Yes)	-	-	74	62%

Pearson's correlation coefficients revealed significant relationships between LBP severity, nutrition, and physical activity (Table 3): A weak negative correlation ($r=-0.28, p<0.05$), indicating that better dietary habits were associated with lower pain levels. A moderate negative correlation ($r=-0.35, p<0.01$), suggesting that regular exercise reduced pain intensity. A positive correlation ($r=0.42, p<0.01$), implying that individuals with healthier diets were more likely to engage in exercise.

Table 3: Correlation Matrix

Variable	LBP Severity	Nutrition	Physical Activity
LBP Severity	1.00	-	-
Nutrition	-0.28*	1.00	-
Physical Activity	-0.35**	0.42**	1.00
**p<0.05; **p<0.01			

Logistic regression assessed predictors of LBP severity (Table 4): **Nutritional Interventions:** Significant negative association (*β=-0.48, p=0.003*), indicating that dietary changes reduced the odds of severe LBP. **Physical Activity:** Stronger negative association (*β=-0.61, p<0.001*), highlighting exercise as a key protective factor. **Synergistic Effect:** The interaction term (*β=-0.33, p=0.008*) demonstrated that combining nutrition and exercise amplified pain relief benefits.

Table 4: Logistic Regression Outcomes

Predictor	Coefficient	p-value
Nutritional Interventions	-0.48	0.003
Physical Activity	-0.61	<0.001
Nutrition × Physical Activity	-0.33	0.008

4. Discussion

The findings of this study align with and expand upon prior research on the roles of nutrition and physical activity in low back pain (LBP) management. Below, we contextualize our results within the broader literature. Our study demonstrated a significant inverse relationship between dietary modifications (e.g., anti-inflammatory diets, calcium supplementation) and LBP severity (*β=-0.48, p=0.003*). This aligns with Visser et al. (2020), who reported that adequate nutrient intake, particularly calcium and anti-inflammatory foods, supports musculoskeletal health. However, Visser's study focused on older adults during the COVID-19 pandemic, whereas our cohort included a broader age range (18–65 years). This suggests that dietary interventions may benefit younger populations as well, though age-specific effects warrant further investigation. Tatta et al. (2022) similarly emphasized nutrition's role in pain management but highlighted the need for clinical integration—a gap our study addresses by proposing actionable dietary guidelines for LBP patients. Regular physical activity was strongly associated with reduced LBP incidence and severity (*β=-0.61, p<0.001*), corroborating Alzahrani et al. (2019), who found that moderate exercise improves spinal stability and reduces biomechanical stress. However, our findings contrast with Sitthipornvorakul et al. (2010), who reported conflicting associations between physical activity and LBP. This discrepancy may stem from differences in activity *type* and *intensity*. For example, our participants engaged primarily in structured aerobic and strength-training exercises, whereas Sitthipornvorakul's review included occupational and high-intensity activities, which may exacerbate pain. This underscores the importance of distinguishing between exercise modalities in future research.

The interaction term (*β=-0.33, p=0.008*) revealed that combining nutrition and physical activity amplifies benefits, a novel contribution to the literature. While prior studies like Amorim et al. (2019) explored mobile health interventions for LBP, few have examined synergistic lifestyle approaches. Our results support Tatta et al.'s (2022) call for integrated strategies, suggesting that combined interventions may enhance metabolic health (e.g., reduced inflammation) and psychological resilience (e.g., increased self-efficacy).

The **Health Belief Model (HBM)** and **Social Cognitive Theory (SCT)** provided a robust framework for interpreting behavioral patterns. Consistent with Sharafkhani et al. (2015), participants who perceived LBP as a significant threat were more likely to adopt dietary changes, aligning with HBM's emphasis on perceived severity. Meanwhile, SCT's focus on self-efficacy explained why individuals with confidence in their exercise capabilities reported lower pain levels. These findings suggest that interventions combining HBM-based education (e.g., highlighting LBP risks) and SCT-driven support (e.g., building exercise confidence) could optimize adherence and outcomes.

Limitations and Future Directions

Like many LBP studies (e.g., Sitthipornvorakul et al., 2010), our reliance on self-reported data may overestimate or misclassify behaviors. Future work should incorporate objective measures (e.g., accelerometers for physical activity, biomarkers for nutrient levels). While efficient, this design limits causal inference. Longitudinal studies, such as Amorim et al.'s (2019) randomized controlled trial, are needed to establish temporality. The predominance of younger participants (70% aged 18–25) may limit generalizability to older adults, who face distinct musculoskeletal challenges.

Future research should adopt longitudinal designs, objective measures, and age-stratified analyses to refine these findings. By bridging theoretical frameworks with practical interventions, this work paves the way for holistic, evidence-based LBP management strategies (Geneen et al., 2017; Foster et al., 2018).

5. Conclusion

This study advances our understanding of nutrition and physical activity as critical, modifiable determinants of LBP. While aligning with broader literature on lifestyle interventions, it uniquely highlights the synergistic potential of combined approaches. Future research should adopt longitudinal designs, objective measures, and age-stratified analyses to refine these findings. By bridging theoretical frameworks with practical interventions, this work paves the way for holistic, evidence-based LBP management strategies. Clinicians should prioritize **patient-centered strategies** that integrate dietary counseling and exercise prescriptions.

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