Status of physical activity and factors related to sarcopenia and cardiovascular disease in Korean older adults

Seong Hui Choi[1], Sun Young Park[2]*

[1]Department of Nursing, Nambu University, Assistant Professor

[1]Nambu University, Nambudae-gil, Gwangsan-gu, Gwangju, Republic of Korea

[2] Departments of Nursing, Gradute School Doctoral Program of Chung-Ang University, Seoul, Republic of Korea

Abstract

Purpose: This descriptive survey study was conducted to identify the current status of physical activity levels and factors related to sarcopenia and cardiovascular disease among Korean older adults, using secondary analysis of data from the 2023 Korea National Health and Nutrition Examination Survey (KNHANES). Despite numerous previous studies, physical inactivity, the rising prevalence of sarcopenia, and insufficient management of cardiovascular risk factors remain serious public health concerns. This study aims to deepen understanding of these issues and provide foundational data for developing more effective future intervention strategies. Method: A total of 1,552 individuals aged 65 years and older (695 men, 857 women) were included using a two-stage stratified cluster sampling method. Complex sample frequency analysis, descriptive statistics, chi-square tests, and independent t-tests were used to analyze gender-based differences in general characteristics and health indicators. Results: Significant gender differences were observed across key variables. Men reported higher levels of resistance training (2.60±2.15 vs. 1.62±1.54 days/week, p<.001) and aerobic activity compliance (37% vs. 29%, p=.002), while women reported longer walking durations (32.88±31.12 vs. 28.22±30.55 minutes/day, p=.003). Handgrip strength was significantly higher in men (32.38±7.32 kg) compared to women (20.85±4.42 kg, p<.001), while total body fat mass was higher in women (20.41±5.78 kg vs. 17.32±5.38 kg, p<.001). Cardiovascular markers also showed gender disparities, including fasting blood glucose (109.25±27.48 mg/dL vs. 103.65±21.89 mg/dL, p<.001), HDL-C (51.22±13.64 mg/dL vs. 57.99±14.92 mg/dL, p<.001), and triglycerides (126.81±73.90 mg/dL vs. 116.76±54.67 mg/dL, p=.003). Conclusion: Gender-based disparities in physical activity, sarcopenia, and cardiovascular health remain prominent among older Korean adults. These findings support the need for more targeted, gender-sensitive interventions in elderly health promotion. Future studies should employ proactive, evidence-based strategies grounded in recent, representative national data to inform effective public health planning.

Keywords: Physical activity, Sarcopenia, Cardiovascular risk, Elderly, Physical activity

Introduction

1. Need for the study

According to a 2020 report by the World Health Organization (WHO), insufficient physical activity contributes to approximately 3.2 million deaths annually, representing a significant global public health issue [1]. Sedentary lifestyles are closely associated with chronic diseases such as cardiovascular disease, diabetes, and certain cancers. Despite widespread awareness of the benefits of physical activity, global adherence to physical activity guidelines remains alarmingly low.

In South Korea, this trend is similarly concerning. The 2019 Chronic Disease Health Statistics published by the Korea Centers for Disease Control and Prevention (KCDC) indicated a decline in physical activity levels among adults, with only 47.8% meeting aerobic activity guidelines and 23.9% engaging in recommended levels of muscle-strengthening exercise. More notably, a mere 16.8% of adults satisfied both criteria [2]. These figures highlight the persistent gap between physical activity recommendations and actual health behavior, raising questions about the effectiveness of existing public health interventions.

Several guidelines, such as those proposed by the American Heart Association (AHA), have outlined evidence-based recommendations to combat sedentary behavior and prevent related conditions such as sarcopenia and cardiovascular disease. These include moderate-intensity aerobic activity for at least 30 minutes five times a week or vigorous-intensity activity three times weekly, along with biweekly resistance training sessions involving major muscle groups [3]. While these guidelines are theoretically sound, their practical implementation and accessibility—especially among older adults—warrant further examination.

Handgrip strength has emerged in the literature as a potential biomarker for musculoskeletal and cardiovascular health. A study using data from the 2016 Korea National Health and Nutrition Examination Survey (KNHANES) demonstrated an inverse relationship between relative handgrip strength and 10-year CVD risk, with notable sex differences in the magnitude of association [4]. Complementary findings from the Korean Longitudinal Study of Aging (2006–2014) linked lower grip strength to increased cardiovascular mortality [5]. Additional studies using U.S. NHANES data reinforced the predictive utility of handgrip strength, associating its decline with elevated risks of metabolic disorders including diabetes, hypertriglyceridemia, and hypertension [6]. However, most of these studies are observational in nature and cross-sectional or retrospective, which limits their ability to establish causal inferences or account for confounding lifestyle variables such as nutrition, socioeconomic status, or comorbidities.

Sarcopenia, characterized by progressive loss of muscle mass and function, has been consistently associated with elevated morbidity and mortality in older adults [7,20]. Yet, there remains a paucity of research exploring the interactive effects of sarcopenia, physical activity, and cardiovascular risk within the Korean aging population. For example, although a Japanese study involving adults aged approximately 65 years found sarcopenia to be associated with higher blood pressure and cholesterol after controlling for covariates [8], there is limited Korean data replicating or expanding upon these findings. Moreover, existing studies often overlook gender-specific physiological and behavioral factors that may mediate these associations.

Thus, this study aims to address these gaps by examining gender differences in physical activity, sarcopenia, and cardiovascular disease risk factors among older Korean adults. By incorporating a gender-sensitive lens and analyzing nationally representative data, this study seeks to contribute to a more nuanced understanding of health disparities in aging. Ultimately, the findings will provide foundational evidence for developing tailored health promotion strategies that are responsive to the diverse needs of the elderly population in South Korea.

II. Methodology

1. Research design

This study is a descriptive survey conducted using secondary analysis of raw data from the Korea National Health and Nutrition Examination Survey (KNHANES), aiming to assess the current status of physical activity and factors related to sarcopenia and cardiovascular disease among Korean older adults.

2. Data collection and participant selection

This study was conducted using raw data from the 9th Korea National Health and Nutrition Examination Survey (KNHANES) in 2023, after receiving approval for data use from the Korea Disease Control and Prevention Agency (KDCA). The sampling frame of KNHANES was constructed based on the most recent Population and Housing Census data available at the time of the sample design.

To ensure a representative sample, a two-stage stratified cluster sampling method was applied, using survey districts and households as sampling units. Based on this method, the study participants were selected. Ultimately, a total of 1,552 individuals aged 65 and older residing in South Korea (695 men and 857 women) were included in the final analysis.

3. Research instruments

(1) General characteristics

In this study, general characteristics included gender, age, marital status, smoking status, type of health insurance (regional subscriber, workplace subscriber, or medical aid recipient), and enrollment in private health insurance. Subjective health perception was measured using the question, "How would you describe your usual health condition?" and assessed on a 5-point Likert scale ranging from 1 (very poor) to 5 (very good). Health literacy was measured using the question, "The following items ask about difficulties you may experience in understanding and using health information. Please indicate($\sqrt{}$) the degree of difficulty you feel," consisting of 10 items rated on a 4-point Likert scale from 1 (not at all) to 4 (very much). The total score for health literacy was calculated by summing Scores of the 10 items. Nutritional status was assessed based

on the amount of food intake, measured in grams (g).

(2) Physical activity

In this study, physical activity was assessed by the number of days per week participants engaged in muscle-strengthening exercises, categorized as 1 day, 2 days, 3 days, 4 days, or 5 or more days. Walking activity was measured in minutes. The rate of aerobic physical activity compliance was calculated based on the number of individuals who met at least one of the following weekly criteria: 150 minutes or more of moderate-intensity physical activity, 75 minutes or more of vigorous-intensity physical activity, or an equivalent combination of both (with 1 minute of vigorous activity equated to 2 minutes of moderate activity).

(3) Sarcopenia indicators

In this study, sarcopenia indicators included handgrip strength (kg) and total body fat mass (including the head). Handgrip strength was measured using a digital grip strength dynamometer (T.K.K. 5401, Japan). Each participant's grip strength was measured twice on both the right and left hands, with a rest period of 30 seconds to 1 minute between measurements. During each measurement, participants were instructed to maintain maximum force for 3 seconds. The average of the two highest values was used in the analysis.

Total body fat mass was assessed via dual-energy X-ray absorptiometry (DEXA)-based data included in the KNHANES dataset.

The selection of handgrip strength as a core indicator of sarcopenia is consistent with the diagnostic criteria recommended by EWGSOP2 (European Working Group on Sarcopenia in Older People, 2019) and AWGS 2019 (Asian Working Group for Sarcopenia).

Both guidelines highlight low muscle strength—particularly handgrip strength—as a primary diagnostic component, due to its strong predictive value for adverse outcomes such as falls, hospitalization, disability, and mortality. In addition, although skeletal muscle mass index (SMI) is often used in clinical settings, grip strength is more

feasible for large-scale population-based studies like KNHANES due to its non-invasive, cost-effective, and portable nature. Total body fat was included to capture the coexistence of excess fat and muscle loss (sarcopenic obesity), which is increasingly recognized as a high-risk phenotype for cardiometabolic diseases in older adults.

(4) Cardiovascular indicators

Cardiovascular indicators in this study were assessed through blood test results, including fasting blood sugar (FBS), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), total cholesterol (TC), triglycerides (TG), and body mass index (BMI).

4. Data analysis method

Considering the representativeness of the Korea National Health and Nutrition Examination Survey data, sampling weights were applied in the analysis. All statistical analyses were conducted using SPSS Windows version 25.0. The specific data analysis methods are as follows:

(1) The general characteristics of the participants were analyzed using complex sample frequency analysis and descriptive statistics.

(2) Differences in general characteristics, cardiovascular indicators, and sarcopenia indicators by gender among older adults were analyzed using complex sample cross-tabulation analysis (χ^2) and independent t-tests.

5. Ethical consideration

The Korea National Health and Nutrition Examination Survey (KNHANES) is a government-led study conducted for the public good, and in accordance with Article 2, Clause 1 of the Bioethics and Safety Act and Article 2, Clause 2, Item 1 of its Enforcement Rules, it can be conducted without review by an institutional review board (IRB).

However, the 2023 data used in this study was approved by the KDCA Institutional Review Board under approval number 2022-11-16-R-A

III. Results

Table 1. General characteristics of the participants (N:1,552)

Variables	Characteristics	n(%) or M±SD
Gender	Man	695(44.8)
	Woman	857(55.2)
Age (year)		72.27±5.02
	65~70	585(37.7)
	70~75	402(25.9)
	75~	565(36.4)
Marital Status	Yes	1102(71.0)
	No	450(29.0)
Smoking	Yes	1117(72)
	No	435(28)
Drinking	Yes	1178(75.9)
	No	374(24.1)
Enrollment in Health Insurance	Workplace	601(38.7)
	Community	853(55.0)
	Medical Aid Program	98(6.3)
Private Health Insurance Enrollment	Yes	960(61.9)
	No	592(38.1)
Health Literacy		27.54±5.79
Self-rated health		2.99±0.95
Dietary Intake(g)		1229.16±600.30

The general characteristics of the participants are presented in Table 1. Among the total participants, 695(44.8%) were men and 857(55.2%) were women, with a mean age of 72.27±5.02 years. The average health literacy score was 27.54±5.79, and the mean score for subjective health perception was 2.99±0.95.

Table 2. Differences in general characteristics between groups were analyzed (N: 1,552)

Variables	Characteristics	Men(n:695)	Woman(n:857)	χ^2 or t	p
		n(%) or M±SD	n(%) or M±SD		
Age(year)		72.37±5.05	72.18±5.0	0.728	.467
	65~70	253(36.4)	332(38.78)	0.92	.631
	70~75	185(26.6)	217(25.3)		
	75~	257(37.0)	308(35.9)		
Marital status	Yes	606(87.2)	496(57.9)	160.23	p<.001
	No	89(12.8)	361(42.1)		
Smoking	Yes	285(41.0)	832(85.1)	598.22	p<.001
	No	410(59.0)	25(2.9)		
Drinking	Yes	640(92.1)	538(62.8)	180.23	p<.001
	No	55(7.9)	319(37.2)		

Enrollment in Health Insurance	Workplace	298(42.9)	303(35.4)	10.76	.005
	Community	362(52.1)	491(57.3)		
	Medical Aid Program	35(5.0)	63(7.3)		
Private Health Insurance Enrollment	Yes	417(60.0)	543(63.4)	1.84	.175
	No	278(40.0)	314(36.6)		
Health Literacy		2.87±1.0	3.09±1.1	-4.65	*p*<.001
Self-rated health		28.12±5.5	27.08±6.0	3.59	*p*<.001
Dietary Intake(g)		1388.456±633.2	1100.17±539.0	9.53	*p*<.001

The results of the analysis on gender differences in general characteristics are presented in Table 2. Statistically significant differences were found by gender in marital status (t=160.23,p<.001), smoking (t=598.22,p<.001), alcohol consumption (t=180.23,p<.001), type of health insurance (t=10.76,p=.005), health literacy (t=−4.65,p<.001), subjective health perception (t=3.59,p<.001), and food intake (t=9.53,p<.001). However, no significant gender differences were found in age (p=.467) or private insurance enrollment status (p=.175).

Table 3. Analysis of gender differences in physical activity (N:1,552)

Variables	Men(n:695)	Woman(n:857)	t	*p*
	n(%) or M±SD	n(%) or M±SD		
Resistance Training Frequency (per week)	2.60±2.15	1.62±1.54	10.04	*p*<.001
Walking Duration (in minutes)	28.22±30.55	32.88±31.12	-2.96	.003
Physical Activities	0.37±0.48	0.29±0.46	3.03	.002

The results of the analysis on gender differences in physical activity are presented in Table 3. The umber of strength training sessions per week was significantly higher in men (2.60±2.15) than in women (1.62±1.54)(p<.001), and the rate of aerobic physical activity was also significantly higher in men (0.37±0.48) than in women (0.29±0.46)(p=.002). In other words, men engaged in both strength training and aerobic physical activity more than women, and these differences were statistically significant (p<.001). However, women (32.88±31.12) walked for longer durations than men (28.22±30.55)(p=.003).

Table 4. Analysis of gender differences in sarcopenia indicators (N: 1,552)

Variables	Men(n:695)	Woman(n:857)	t	*p*
	n(%) or M±SD	n(%) or M±SD		
Grip Strenght (kg) (Rt)	32.38±7.32	20.85±4.42	34.445	*p*<.001
Total Body Fat Mass	17.32±5.38	20.41±5.78	-10.144	*p*<.001

The results of the analysis on gender differences in sarcopenia indicators are presented in Table 4. A significant gender difference was found in right-hand grip strength, with men (32.38±7.32) showing higher

values than women (20.85±4.42)(p<.001). Total body fat mass (including the head) also showed a significant gender difference, with men at 19.60±4.38 and women at 20.41±5.78(p<.001)

Table 5. Analysis of gender differences in cardiovascular indicators (N: 1,552)

Variables	Men(n:695)	Woman(n:857)	t	P
	n(%) or M±SD	n(%) or M±SD		
FBS(mg/dl)	109.25±27.48	103.65±21.89	4.307	p<.001
HDL-C(mg/dl)	51.22±13.64	57.99±14.92	-9.158	p<.001
LDL-C(mg/dl)	97.27±34.68	104.47±38.67	-3.761	p<.001
TC(mg/dl)	165.13±37.94	178.05±41.63	-6.231	p<.001
TG(mg/dl)	126.81±73.90	116.76±54.67	3.028	.003
BMI(kg/m^2)	23.75±2.97	24.29±3.27	-3.307	p<.001

FBS=fasting blood sugar; HDL=High Density Lipoprotein; LDL=Low-Density Lipoprotein; TC=Total cholesterol; TG= Triglyceride; BMI=body mass index

The results of the analysis on gender differences in cardiovascular indicators are presented in Table 5. Significant gender differences were found in fasting blood sugar (men 109.25±27.48, women 103.65±21.89), high-density lipoprotein cholesterol (men 51.22±13.64, women 57.99±14.92), low-density lipoprotein cholesterol (men 97.27±34.68, women 104.47±38.67), total cholesterol (men 165.13±37.94, women 178.05±41.63), and body mass index (men 23.75±2.97, women 24.29±3.27)(p<.001). In addition, a significant gender difference was also found in triglyceride levels (men 126.81±73.90, women 116.76±54.67)(p=.003).

IV. Discussion

This study aimed to provide foundational data for systematic health management by examining the current status of physical activity and factors related to sarcopenia and cardiovascular disease among Korean older adults, using raw data from the Korea National Health and Nutrition Examination Survey (KNHANES). The findings revealed statistically significant gender differences in physical activity, sarcopenia indicators, and cardiovascular disease-related factors. The following discussion addresses these findings while also considering their clinical relevance and real-world implications. In this study, men engaged more in both resistance and aerobic physical activities than women, while women walked for longer durations than men. Although the 4.66-minute difference in walking duration (men: 28.22±30.55 min, women: 32.88±31.12 min) may appear modest, such a difference may still carry clinical implications. For instance, previous research has shown that each additional 5 minutes of daily walking can reduce the risk of cardiovascular mortality by up to 7% in older adults[9-10]. Furthermore, consistent engagement in walking has been associated with improved glycemic control, enhanced mood, and better mobility. Therefore, even small differences in daily walking duration could translate into meaningful improvements in long-term health outcomes, particularly for older women.

Regarding sarcopenia indicators, men demonstrated significantly higher handgrip strength than women, while women had higher total body fat mass. Although such gender-based differences are well established in the literature, their clinical consequences are especially important in the context of aging. Specifically, a study based on KNHANES data reported that a 1 kg increase in handgrip strength was associated with a 1.29% reduction in 10-year cardiovascular disease (CVD) risk in men and a 0.58% reduction in women[11-12]. Given that the gender difference in handgrip strength observed in this study was over 11 kg, the implied difference in CVD risk prediction is potentially substantial and clinically significant. These results suggest that handgrip strength may serve not only as a diagnostic marker of muscular health, but also as a practical screening tool for early identification of individuals at high cardiovascular risk.

Moreover, high total body fat combined with low muscle mass — a condition often referred to as

sarcopenic obesity — is associated with elevated risks of insulin resistance, inflammation, and cardiovascular disease. The fact that women in this study had both higher body fat mass and lower grip strength suggests they may be more vulnerable to sarcopenic obesity and its complications, emphasizing the need for early gender-specific interventions.

Lastly, the study identified gender differences in multiple cardiovascular indicators, including fasting blood sugar (FBS), HDL-C, LDL-C, total cholesterol, triglycerides, and BMI. While these differences were statistically significant, their clinical relevance becomes clearer when viewed in light of existing thresholds for cardiovascular risk. For example, men had a mean FBS of 109.25 mg/dL, placing them in the impaired fasting glucose range, which is a well-established precursor to type 2 diabetes and an independent risk factor for cardiovascular events. Additionally, HDL-C levels — known for their protective effect — were lower in men (51.22 mg/dL) than women (57.99 mg/dL), with each 1 mg/dL increase in HDL-C linked to a 2-3% decrease in CVD risk [13-14]. These cumulative differences, though individually small, may synergistically increase cardiovascular vulnerability over time.

Taken together, these findings do more than highlight statistical disparities; they point toward clinically meaningful differences that could inform individualized and gender-sensitive health strategies. As Korea approaches a super-aged society, such insights are essential for designing prevention and intervention programs tailored to the specific risks and needs of elderly men and women[15].

Future research should continue to examine how these gender-related differences interact with other lifestyle and biological variables, and should consider longitudinal and intervention-based approaches to clarify causal pathways.

V. Conclusion

This study assessed gender differences in physical activity, sarcopenia-related indicators, and cardiovascular disease (CVD) risk factors among older adults in South Korea. The analysis revealed that older men participated more frequently in strength training and aerobic physical activities, while women engaged in longer walking durations. Despite higher muscle strength among men, they exhibited less favorable outcomes in certain CVD risk markers such as fasting blood glucose and triglyceride levels. These findings suggest that physical function, sarcopenia risk, and cardiovascular health present differently across genders, emphasizing the importance of gender-sensitive approaches in elderly healthcare and public health planning.

Given these differences, intervention programs should be tailored to address the unique vulnerabilities and strengths of each gender. For example, public health campaigns aimed at older women might focus on improving access to resistance training through community-based exercise programs that accommodate caregiving roles and foster peer support. For older men, interventions might prioritize sustained motivation post-retirement and the management of metabolic risk factors such as blood glucose and lipid profiles.

At the policy level, findings from this study support the integration of gender-specific health screenings in national health check-up programs, particularly focusing on sarcopenia screening using grip strength and CVD risk profiling by sex. Moreover, the establishment of multi-disciplinary elderly wellness centers—equipped with physiotherapists, dietitians, and mental health professionals—could help deliver individualized care plans, especially in underserved rural areas where access disparities are more pronounced.

Future research should go beyond descriptive findings and evaluate the effectiveness of gender-differentiated interventions in reducing disease burden and improving health equity in the aging population. Longitudinal and experimental studies are needed to determine causal pathways and guide the development of actionable guidelines.

In summary, the aging Korean society faces distinct gender-related health challenges that require customized strategies grounded in evidence-based data. By aligning national policy with gender-responsive care, we can move toward a more equitable and effective public health system for older adults.

References

[1] World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. Geneva: WHO.

[2] Korea Centers for Disease Control and Prevention. (2021). 2019 National Health Statistics: Chronic Disease and Health Indicators. Cheongju: KCDC.

[3] American Heart Association. (2022). Physical activity recommendations for adults. Retrieved from https://www.heart.org

[4] Jo, J., et al. (2019). Association between handgrip strength and 10-year cardiovascular risk in Korean adults: Based on the 2016 Korea National Health and Nutrition Examination Survey. Korean Journal of Family Medicine, 40(3), 157–164.

[5] Kim, Y., et al. (2019). Low handgrip strength as a predictor of cardiovascular mortality in Korean older adults: Evidence from the Korean Longitudinal Study of Aging (KLoSA). Journal of Geriatric Cardiology, 16(2), 120–127.

[6] Peterson, M. D. (2017). Grip strength associates with cardiovascular and metabolic disease biomarkers in older adults: Findings from NHANES 2011–2014. Journal of Gerontology: Medical Sciences, 72(3), 431–438.

[7] Bayraktar, D., et al. (2020). Sarcopenia and its impact on hospitalization and mortality in older adults: A systematic review. Journal of Aging and Health, 32(5–6), 349–362.

[8] Hida, T., & Imagama, S. (2018). Sarcopenia is associated with higher atherosclerosis risk factors in older adults: A cross-sectional study. Geriatrics & Gerontology International, 18(3), 449–455.

[9] Roh, S.Y., & Chang, I.Y. (2024). The ecological system's influence on physical activities of older adults: comparison between older men and women. Aging Clinical and Experimental Research, 37(1), 16. https://doi.org/10.1007/s40520-024-02908-2

[10] Kong, S., & So, W.-Y. (2024). Gender differences in body composition, physical activity level, physical fitness, and bone mineral density among elderly individuals living alone compared to those living with their spouses. Healthcare, 12(2), 186. https://doi.org/10.3390/healthcare12020186

[11] Kim, Y., et al. (2019). Handgrip strength and cardiovascular mortality in older Korean adults: Korean Longitudinal Study of Aging. Korean Journal of Family Medicine, 40(3), 173–180.

[12] Peterson, M. D. (2017). Grip strength thresholds for clinically relevant weakness. The Journals of Gerontology: Series A, 72(3), 382–388.

[13] Roh, S. Y., & Chang, I. Y. (2024). The ecological system's influence on physical activities of older adults: Comparison between older men and women. Aging Clinical and Experimental Research, 37, Article 16.

[14] Lee, Y. J., et al. (2018). Fasting blood glucose and incidence of cardiovascular disease among Korean elderly: A prospective cohort study. Diabetes & Metabolism Journal, 42(4), 312–319. https://doi.org/10.4093/dmj.2018.42.4.312

[15] Park, J. H., & Kim, Y. S. (2020). Gender differences in cardiovascular disease risk factors among older adults in Korea. Journal of the Korean Geriatrics Society, 24(3), 125–133. https://doi.org/10.4235/jkgs.2020.24.3.125

[16] Jam, F. A. (2019). CRYPTO CURRENCY–A NEW PHENOMENON IN MONETARY CIRCULATION. Central Asian Journal of Social Sciences and Humanities, 4(1), 39-46.

[17] Jam, F. A., Singh, S. K. G., Ng, B., & Aziz, N. (2016). Effects of Uncertainty Avoidance on Leadership Styles in Malaysian Culture, , International Journal of Advance Business and Economics Research, 14(8), 7029-7045.

[18] Sobhani, Parvaneh, and Afshin Danehkar. "Investigating the trend of precipitation changes and occurrence of droughts in the Mesopotamian Plain." Environment and Water Engineering 11, no. 3 (2025): e211938.

[19] Kandoli, L. "Effect of food shelf life on food quality." Journal of Advances in Humanities and Social Sciences 8, no. 1 (2022).

[20] Malika AIT NASSER. (2025). The Cultural Industry: An Embryonic State in the Face of Associative Motivation. Journal of Advanced Research in Social Sciences and Humanities, 10(2), 20-26.