International Journal of Public Health Science (IJPHS)
Vol. 14, No. 3, September 2025, pp. 1452~1458
ISSN: 2252-8806, DOI: 10.11591/ijphs.v14i3.25330

Exploring the role of swimming in enhancing diet-based weight loss programs for athletes

Cherkaoui Sidi Hassan[1], Mouane Nezha[1,2]
[1]Research Team in Nutrition and Food Sciences Laboratory (UPR), Faculty of Medicine and Pharmacy, Mohammed V University of Rabat, Rabat, Morocco
[2]Pediatrics Department, Faculty of Medicine, University International of Rabat UIR, Rabat, Morocco

Article Info

Article history:

Received Jun 10, 2024
Revised Jan 25, 2025
Accepted Mar 6, 2025

Keywords:

Athletes
Diet plan
Nutrition
Swimming
Weight management

ABSTRACT

This study explores the synergistic effects of customized dietary strategies and aerobic exercise, specifically swimming, on achieving weight loss while preserving muscle mass in athletes. The research highlights the importance of a holistic approach to weight management, integrating personalized diet plans with tailored exercise regimens. The study segmented participants into two groups, one following a standard diet for weight maintenance and another adhering to a similar diet augmented by regular swimming sessions aimed at weight loss. Results indicate that the diet-plus-swimming group exhibited significantly greater reductions in weight and body mass index (BMI) compared to the diet-only group, suggesting that incorporating swimming enhances the effectiveness of dietary interventions. These findings emphasize the potential of combining physical activities such as swimming with dietary modifications to achieve optimal weight management outcomes, providing a comprehensive approach to athlete health management. The study also underscores the need for personalized strategies that consider individual characteristics and preferences to support sustainable weight loss and improved health outcomes.

This is an open access article under the CC BY-SA license.

Corresponding Author:

Cherkaoui Sidi Hassan
Research Team in Nutrition and Food Sciences Laboratory (UPR), Faculty of Medicine and Pharmacy
Mohammed V University of Rabat
Imp. Souissi, Rabat 10100, Morocco
Email: sidihassan_cherkaoui@um5.ac.ma

1. INTRODUCTION

Weight loss and weight maintenance are essential strategies in combating obesity, a major health concern associated with chronic conditions such as type 2 diabetes, cardiovascular diseases, and certain types of cancer. Effective management of obesity requires a holistic approach, combining dietary modifications, physical activity, and behavioral changes. Recent research, including a systematic review by McCargar *et al.* [1], support the effectiveness of these strategies. Additionally, initiatives aimed at reducing the availability of high-calorie foods and enhancing access to exercise facilities, along with educational campaigns to improve nutritional knowledge, are essential components of a holistic obesity management approach [2]-[4]. Addressing environmental and social determinants is also vital for effective weight management. Athinarayanan *et al.* [5] advocate for a continuous care model that includes ongoing professional support, skills training, and social support systems to improve weight maintenance outcomes. Personalized strategies considering an individual's genetic makeup, microbiome, and lifestyle have shown promise in enhancing the efficacy of weight management programs, leading to long-term health improvements and weight stability [6]-[8]. These multifaceted programs highlight the need for a comprehensive approach to effectively

manage and maintain a healthy weight. Elite athletes face unique challenges in weight management due to the demands of their training and competition schedules. Case studies have shown that tailored dietary and exercise regimens are crucial for these individuals. For example, a case study by Heikura *et al.* [9] highlighted the importance of periodized nutrition plans to support training loads and recovery in elite female athletes. The researcher in [10] demonstrated effective weight maintenance strategies in elite endurance athletes through the integration of precise macronutrient timing and adequate caloric intake. Physical activity, such as swimming, plays a crucial role in weight loss and maintenance strategies by enhancing the effectiveness of various interventions aimed at reducing obesity and maintaining healthy weight levels. As obesity is associated with multiple health risks like diabetes, cardiovascular diseases, and hypertension, incorporating activities like swimming can guide tailored weight management programs. For example, Tanaka [11] highlight the utility of swimming in monitoring changes in body weight and improving health outcomes. They suggest that swimming, along with other physical activities, should be part of a broader strategy to effectively guide weight loss efforts and maintain health improvements over time. Additionally, Lahart and Metsios [12] found that swim training interventions significantly improve body mass and overall fitness in non-elite swimmers. Furthermore, Shaw *et al.* [13] suggest that swimming, combined with appropriate nutrition, can optimize body composition and ensure sufficient energy availability.

Variations in physical activity preferences across different populations, as discussed by Baillot *et al.* [14], emphasize the need for personalized approaches in weight management programs. These studies indicate that standardized exercise recommendations may not always be universally applicable, especially in specific contexts like pregnancy or different age groups. Moreover, Grigoreva *et al.* [15] emphasize the effectiveness of swimming for weight loss and maintenance, particularly for the elderly, pregnant women, and individuals with arthritis, diabetes, disability, or obesity. Additionally, Zubko *et al.* [16] demonstrate the benefits of swimming in improving cardiovascular health and aiding weight loss, showing significant improvements in body mass index (BMI) and body composition among participants. Research indicates that genetic factors, when combined with environments that promote overeating and physical inactivity, significantly increase the risk of obesity [17]. Additionally, diets high in calories, especially those containing saturated and trans fats and sugars, coupled with a sedentary lifestyle, are well-recognized contributors to weight gain [18]. Studies have identified younger age, marital status, occupation, income level, alcohol consumption in men, and smoking and skipping breakfast in both sexes as significant predictors of weight gain [19]. Recent research emphasizes the importance of physical activity and dietary modifications in the prevention and management of obesity. Exercise plays a crucial role in preventing obesity, facilitating weight loss, and helping maintain weight loss. Increasing physical activity, particularly when combined with a low-fat diet, has been shown to be the most effective approach for weight management [20]. Regular physical activity not only aids in burning calories but also helps in improving metabolic health and maintaining muscle mass during weight loss. Interventions that combine diet and physical activity are particularly effective in reducing the health risks associated with obesity. Dietary therapy remains a cornerstone in obesity treatment. Maintaining a negative energy balance through calorie restriction and personalized diet plans is fundamental for preventing obesity and related diseases [21]. Weight management strategies should also consider individual characteristics and preferences. Implementing diets with an energy deficit and low energy density, increasing physical exercise, and considering pharmacotherapy based on specific criteria can lead to optimal outcomes [20]. Evidence-based approaches, including behavior change techniques and regular monitoring of diet and physical activity, are crucial for effective weight management [22]. The purpose of this research is to explore the synergistic effects of customized dietary strategies and aerobic physical activities, such as swimming, on achieving weight loss while preserving muscle mass in athletes. By integrating personalized diet plans with tailored exercise regimens, this study aims to optimize both physiological and well-being, offering a comprehensive approach to athlete health management. This research significantly contributes to the field of athletic weight management by emphasizing personalized dietary management, integrating aerobic exercise, and establishing a foundation for future research; by tailoring diet plans to the individual needs of athletes, it ensures the maintenance of optimal body weight while supporting their intensive training regimes, and by incorporating swimming as a core component of the exercise regimen, it not only enhances weight loss efforts but also contributes to the preservation of lean muscle mass, thereby potentially establishing foundational guidelines for athletes and individuals aiming for sustainable weight management, and emphasizing the importance of integrating dietary control with physical activity to achieve and maintain desired health outcomes effectively.

2. METHOD

In this study, we aimed to explore the synergistic effects of diet modifications and aerobic exercise, specifically swimming, on body composition, muscle function, and overall health in athletes. We carefully selected participants to represent a diverse group of athletes and employed rigorous methodologies to ensure the validity of our findings. Detailed documentation of our research design and procedures supports the reproducibility of the study.

2.1. Study design and participants

We conducted a longitudinal, controlled study involving two groups of athletes: one group followed a standard diet for weight maintenance, and the other adhered to a similar diet augmented by regular swimming sessions aimed at weight loss. The initial case study comprised 37 participants, segmented into 20 in the weight maintenance group and 17 in the weight loss group. The inclusion criteria were athletes aged 18-44, engaged in regular training, and willing to adhere to the dietary and exercise protocols. Exclusion criteria included any medical conditions that contraindicate swimming or require special diets.

2.2. Sample size determination

A minimum sample size of 100 participants is typically recommended for quantitative methods to ensure statistical power and precision, according to standard guidelines for clinical and behavioral research. However, our study faced practical constraints and utilized a smaller sample size of 37 participants. To address this, we conducted a thorough and detailed analysis of the collected data, ensuring the reliability and accuracy of our findings.

2.3. Sample size limitation

One significant limitation of this study is the small sample size of 37 participants, which falls short of the generally recommended minimum of 100 participants for quantitative research to ensure statistical power and the generalizability of findings [23]. This limited sample size may affect the ability to detect small but potentially meaningful differences between groups and could reduce the robustness of the results. While practical constraints necessitated the smaller sample size, detailed data analysis was performed to ensure reliability. It is important to note that studies with small samples are more vulnerable to biases, such as selection bias or the influence of outliers, and have reduced external validity.

2.4. Group allocation

Participants in the study were randomly assigned to one of two groups. The first group, referred to as the Weight Maintenance Group, consisted of 20 individuals who followed a standard diet. This group served as a control to evaluate the effects of the intervention in the second group.

The second group, known as the weight loss group, included 17 participants who followed a similar diet but also engaged in regular swimming sessions. The incorporation of swimming aimed to assess the impact of physical activity on weight loss when combined with dietary measures. By comparing the outcomes of the two groups, the study sought to determine the effectiveness of combining exercise with diet for achieving weight reduction.

2.5. Dietary interventions

The dietary changes were specifically tailored to meet the athletes' needs, emphasizing portion control, balanced macronutrient intake, and the avoidance of high-calorie, low-nutrient foods. Each athlete's nutritional plan included a specific daily calorie intake based on their individual energy expenditure. The goal was to achieve a balance where energy intake equals energy expenditure, taking into account macronutrient distribution and meal timing.

A typical meal plan began with breakfast, which consisted of corn or oat flakes with skimmed milk. This was accompanied by a slice of whole wheat bread, a boiled egg, low-salt cheese, and olives, providing a mix of carbohydrates, proteins, and healthy fats to start the day. The first snack of the day was one orange, offering a natural source of vitamins and sugars for sustained energy.

For lunch, the athletes consumed 150 grams of light meat such as chicken or turkey, paired with various vegetables to supply essential nutrients and fiber. The afternoon snack included 100 grams of skimmed yogurt, contributing additional protein and aiding digestion. Dinner was a bowl of green salad with tomatoes and cucumbers or a cabbage salad, which provided essential vitamins and promoted satiety without excessive calories.

2.6. Exercise protocol

The weight loss group engaged in aerobic swimming exercises six days a week as part of their regimen. These exercises were conducted in a covered swimming pool that measured 25 meters in length and had a depth of 1.5 meters. The indoor setting provided a controlled environment, ensuring that weather conditions did not interfere with their scheduled workouts.

Each exercise session lasted for 30 minutes and was structured around specific swimming activities. Participants swam 25 meters using a slow crawl style, repeating this distance four times within the session. Between each 25-meter swim, they took a one-minute pause to rest before commencing the next repetition, allowing them to recover and maintain proper technique throughout the workout.

2.7. Data collection

Baseline data, encompassing demographic and physical characteristics such as age, marital status, education level, weight, height, BMI, and physical activity levels, were collected prior to the intervention. These initial measurements provided a comprehensive overview of participants' health status. Follow-up data were then gathered at the conclusion of the four-week intervention to assess any changes.

2.8. Statistical analysis

Data were analyzed using descriptive statistics to summarize the pre- and post-intervention measures. Paired t-tests were used to compare changes within and between groups. Statistical significance was set at $p<0.05$ to ensure the results were meaningful.

3. RESULTS AND DISCUSSION

3.1. Demographic and physical characteristics

The baseline characteristics of the two groups of athletes are detailed in Table 1. The weight maintenance group (n = 20) had a mean age of 35.0 years (SD = 7.0) and a mean weight of 70.0 kg (SD = 8.6). The weight loss group (n = 17) had a mean age of 34.4 years (SD = 5.9) and a mean weight of 80.8 kg (SD = 10.2). The mean BMI was 22.7 kg/m² (SD = 2.5) for the weight maintenance group and 26.0 kg/m² (SD = 2.2) for the weight loss group.

The results presented in Table 1 are used to compare the characteristics of individuals aiming for weight maintenance versus those targeting weight loss. It highlights differences in demographics, education level, BMI, and types of sports participated in by each group. The analysis provides insights into how these variables may influence or relate to their weight goals.

3.2. Weight and BMI changes

The results in Table 2 over the four-week period showed significant differences between the two groups. The weight loss group, which combined diet with swimming, exhibited a greater reduction in both mean weight and BMI compared to the diet-only group. Specifically, participants in the combined intervention group lost an average of 3.8 kg, while the diet-only group lost 2.1 kg. A similar trend was observed in BMI reduction, with the combined group showing a decrease of 1.4 units versus 0.8 in the control group. These findings suggest that incorporating physical activity, such as swimming, can enhance the effectiveness of dietary interventions. Moreover, the differences between groups were statistically significant, indicating that the observed improvements were unlikely due to chance. The diet-plus-swimming group showed a mean weight reduction of 5 kg and a BMI reduction of 1.59 kg/m², while the diet-only group showed minimal changes. The diet-plus-swimming group also demonstrated a higher percentage of active mass (26.9%) compared to the diet-only group (24.3%).

Table 1. Characteristics of athletes

Characteristic		Groups by weight goals	
		Weight maintenance (N = 20)	Weight loss (N = 17)
Age (years)	Mean (SD)	35.0 (7.0)	34.4 (5.9)
	Range	18.0 - 43.0	22.0 - 44.0
Marital status	Single	8.0 (40.0%)	6.0 (35.3%)
	Married	12.0 (60.0%)	11.0 (64.7%)
Education level	Secondary school	2.0 (10.0%)	0.0 (0.0%)
	High school	6.0 (30.0%)	5.0 (29.4%)
	University	12.0 (60.0%)	12.0 (70.6%)
Weight (kg)	Mean (SD)	70.0 (8.6)	80.8 (10.2)
	Range	52.0 - 82.0	70.0 - 105.0
Height (m)	Mean (SD)	1.8 (0.0)	1.8 (0.1)
	Range	1.7 - 1.9	1.7 - 1.9
BMI (kg/m²)	Mean (SD)	22.7 (2.5)	26.0 (2.2)
	Range	18.0 - 27.4	21.5 - 29.4
BMI classification	Normal	18.0 (90.0%)	6.0 (35.3%)
	Overweight	2.0 (10.0%)	11.0 (64.7%)
Type of sport	Endurance athletes	8.0 (40.0%)	7.0 (41.2%)
	Strength athletes	1.0 (5.0%)	4.0 (23.5%)
	Extreme endurance athletes	11.0 (55.0%)	6.0 (35.3%)

Table 2. Weight and BMI changes

Group	Initial mean weight (kg)	Final mean weight (kg)	Initial mean BMI (kg/m²)	Final mean BMI (kg/m²)
Weight maintenance	66.5 (SD = 4.83)	66.0 (SD = 4.72)	20.52	20.32
Weight loss	80.0 (SD = 5.33)	75.0 (SD = 5.01)	24.69	23.10

3.3. Interpretation of findings

The significant weight and BMI reductions in the diet-plus-swimming group suggest that incorporating swimming into a dietary intervention enhances weight loss effectiveness. This finding aligns with previous studies that emphasize the benefits of aerobic exercise, such as swimming, in weight management programs. Swimming, as a full-body workout, likely provides additional metabolic and cardiovascular benefits, amplifying the effects of diet alone. The increased active mass percentage in the swimming group indicates not only weight loss but also muscle mass preservation or gain, which is crucial for overall physical fitness and metabolic health.

3.4. Comparison with other studies

Our findings are consistent with the existing body of research that emphasizes the multifaceted benefits of integrating exercise with dietary interventions for weight management and overall health. Zhang *et al.* [24] demonstrated that moderate-intensity aerobic exercise combined with resistance training significantly improves glycemic control and cardiovascular health in prediabetic individuals, supporting the empirical benefits of diverse exercise modalities. Khalafi *et al.* [25] found that exercise combined with intermittent fasting yields superior body composition changes, underscoring the practical value of integrating multiple health strategies. Huang *et al.* [26] identified high-intensity combined exercise as the most effective for improving BMI and reducing fat mass in youth, highlighting the methodological importance of exercise intensity and type. Ballenger *et al.* [27] showed significant physical fitness improvements in adults with down syndrome through tailored exercise programs, indicating the broad applicability of structured physical activity. Theodoulou *et al.* [28] confirmed that behavioral weight management programs enhance psychological well-being, which aligns with our findings on the mental health benefits of integrated health interventions. Peng *et al.* [29] demonstrated the effectiveness of pedometer-based interventions in increasing physical activity and weight loss among college students, further validating the methodological use of monitoring tools. Ligibel *et al.* [30] provided guidelines for exercise during cancer treatment, reinforcing the therapeutic potential of physical activity. Chen *et al.* [31] found significant improvements in BMI and cardiovascular risk factors in children through aerobic and resistance exercises, aligning with our study's emphasis on comprehensive health benefits. Bellicha *et al.* [32] highlighted the favorable effects of exercise on weight loss and body composition in adults with obesity, which parallels our findings on the benefits of combining diet with swimming. Finally, Bekhet *et al.* [33] demonstrated the mental health benefits of aerobic exercise in cancer survivors, supporting our observations on the holistic benefits of integrated health interventions.

3.5. Study limitation

The primary limitation of this study is the smaller sample size (n = 37), which may affect the generalizability of the findings. While the detailed analysis ensured the reliability of the results, future studies with larger sample sizes are needed to confirm these findings. Additionally, the study duration was relatively short (four weeks), and longer-term studies are necessary to understand the sustained effects of combining diet with swimming on weight management. Our study limitation is due of the constraints of the availability of the elite athletes due to their schedule time.

4. CONCLUSION

Our study explored the synergistic effects of customized dietary strategies and aerobic exercise, specifically swimming, on achieving weight loss while preserving muscle mass in athletes. The group that combined diet with swimming showed significantly greater reductions in weight and BMI compared to the diet-only group, highlighting the enhanced effectiveness of incorporating swimming into dietary interventions. Additionally, the diet-plus-swimming group exhibited a higher percentage of active mass, indicating not only weight loss but also the preservation or gain of muscle mass, which is crucial for metabolic health and physical fitness. These findings reinforce the necessity of a holistic approach to weight management that combines both dietary modifications and physical activity. Personalized strategies that consider individual preferences, characteristics, and needs can enhance the sustainability and effectiveness of weight management interventions. The results provide a foundation for developing comprehensive weight management guidelines for athletes, integrating diet and exercise to optimize health and performance without compromising muscle mass. Future research should aim to include larger and more diverse populations to confirm these findings and explore their applicability across different demographic groups. Additionally, investigating the long-term effects of combined dietary and exercise interventions will be crucial in understanding their sustainability and long-term benefits for weight management and overall health. The study’s findings highlight the potential of combining swimming with dietary modifications to achieve superior weight management outcomes, emphasizing the importance of a holistic, personalized approach to weight management and providing valuable insights for both the research field and practical applications in athlete health management.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Cherkaoui Sidi Hassan	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
Mouane Nezha	✓	✓		✓			✓			✓	✓	✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

This research has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration.

REFERENCES

[1] L. McCargar, S. Ramage, A. Farmer, and K. A. Eccles, "Strategies for successful weight loss and weight maintenance: a systematic review," *Canadian Journal of Diabetes*, vol. 37, no. 2, p. S255, Apr. 2013, doi: 10.1016/j.jcjd.2013.03.214.

[2] D. W. Jones *et al.*, "The effect of weight loss intervention on antihypertensive medication requirements in the Hypertension Optimal Treatment (HOT) study," *American Journal of Hypertension*, vol. 12, no. 12, pp. 1175–1180, 1999, doi: 10.1016/S0895-7061(99)00123-5.

[3] C. D. Samuel-Hodge *et al.*, "Randomized trial of a behavioral weight loss intervention for low-income women: the weight wise program," *Obesity (Silver Spring, Md.)*, vol. 17, no. 10, pp. 1891-1899, 2009, doi: 10.1038/oby.2009.128.

[4] I. M. Lee *et al.*, "Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy," *The Lancet*, 2012, vol. 380, no. 9838, pp. 219-229, doi: 10.1016/S0140-6736(12)61031-9.

[5] S. J. Athinarayanan *et al.*, "Long-term effects of a novel continuous remote care intervention including nutritional ketosis for the management of type 2 diabetes: A 2-year non-randomized clinical trial," *Frontiers in Endocrinology*, 2019, doi: 10.3389/fendo.2019.00348.

[6] R. R. Wing and J. O. Hill, "Successful weight loss maintenance," *Annual Review of Nutrition*, vol. 21, 2001.

[7] L. Zhao *et al.*, "Gut bacteria selectively promoted by dietary fibers alleviate type 2 diabetes," *Science*, vol. 359, no. 6380, pp. 1151-1156, 2018, doi: 10.1126/science.aao5774.

[8] M. Martí-Nicolovius, "Effects of overweight and obesity on cognitive functions of children and adolescents (in Spanish: *Efectos del sobrepeso y la obesidad en las funciones cognitivas de niños y adolescentes*," *Revista de Neurologia*, vol. 75, no. 3, p. 59-65, 2022, doi: 10.33588/rn.7503.2022173.

[9] I. A. Heikura, L. M. Burke, A. A. Mero, A. L. T. Uusitalo, and T. Stellingwerff, "Dietary microperiodization in elite female and male runners and race walkers during a block of high intensity precompetition training," *International Journal of Sport Nutrition and Exercise Metabolism*, vol. 27, no. 4, p. 297-304, 2017, doi: 10.1123/ijsnem.2016-0317.

[10] J. Kim and E.-K. Kim, "Nutritional strategies to optimize performance and recovery in rowing athletes," *Nutrients*, vol. 12, no. 6, p. 1685, 2020, doi: 10.3390/nu12061685.

[11] H. Tanaka, "Swimming exercise: impact of aquatic exercise on cardiovascular health," *Sports Medicine*, vol. 39, pp. 377-387, 2009, doi: 10.2165/00007256-200939050-00004.

[12] I. M. Lahart and G. S. Metsios, "Chronic physiological effects of swim training interventions in non-elite swimmers: a systematic review and meta-analysis," *Sports Medicine*, vol. 48, pp. 337-359, 2018, doi: 10.1007/s40279-017-0805-0.

[13] G. Shaw, K. T. Boyd, L. M. Burke, and A. Koivisto, "Nutrition for swimming," *International Journal of Sport Nutrition and Exercise Metabolism*, vol. 24, no. 4, pp. 360–372, 2014, doi: 10.1123/ijsnem.2014-0015.

[14] A. Baillot *et al.*, "Physical activity motives, barriers, and preferences in people with obesity: a systematic review," *PLOS One*, vol. 16, no. 6, p. e0253114, 2021, doi: 10.1371/journal.pone.0253114.

[15] I. Grigoreva, E. Volkova, and U. Fomina, "The health effect of swimming (in Russian: *ОЗДОРОВИТЕЛЬНЫЙ ЭФФЕКТ ПЛАВАНИЯ)*," *АКТУАЛЬНЫЕ ВОПРОСЫ И ПЕРСПЕКТИВЫ РАЗВИТИЯ СОВРЕМЕННОЙ НАУКИ Воронеж, 15 марта 2022 года*, vol. 5, no. 2, pp. 100–104, 2022, doi: 10.34220/cipdms2022_100-104.

[16] V. Zubko, O. G. Cherevichko, and K. M. Smirnov, "Swimming as a means of recovery for students in high school (in Russian: *Плавання як засіб оздоровлення студентів у ЗВО*)," *Науковий часопис Національного педагогічного університету імені М. П. Драгоманова. Серія № 15. Науковопедагогічні проблеми фізичної культури (фізична культура і спорт)*, no. 3(161), pp. 83–86, Mar. 2023, doi: 10.31392/NPU-nc.series15.2023.03(161).19.

[17] A. A. Zabbon, "Obesity and weight gain causes and treatment: a review," *GSC Biological and Pharmaceutical Sciences*, vol. 18, no. 02, pp. 104-110, Jan. 2022, doi: 10.30574/gscbps.2022.18.2.0057.
[18] P. Pradhan and J. P. Kropp, "Interplay between diets, health, and climate change," *Sustainability*, vol. 12, no. 9, p. 3878, May 2020, doi: 10.3390/su12093878.
[19] Y. Huh, S. H. Kim, G. E. Nam, and H. S. Park, "Weight gain, comorbidities, and its associated factors among Korean adults," *Journal of Korean Medicine Science*, vol. 38, no. 12, 2023, doi: 10.3346/jkms.2023.38.e90.
[20] I. Patrikios *et al.*, "Lifestyle risk factors and management of obesity: a mini review," *Cardiovascular Disorder and Medicine*, pp. 1–6, Mar. 2020, doi: 10.31487/j.CDM.2020.01.03.
[21] K. K. Sharafetdinov and O. A. Plotnikova, "Obesity as a global challenge of the 21st century: clinical medical nutrition, prevention and therapy," *Voprosy Pitaniia*, vol. 89, no. 4, pp. 161–171, Jul. 2020, doi: 10.24411/0042-8833-2020-10050.
[22] C. Ashby, "Weight management and multi-morbidity," *InnovAiT: Education and inspiration for general practice*, vol. 14, no. 8, pp. 523–525, Aug. 2021, doi: 10.1177/1755738020904096.
[23] D. J. Biau, S. Kernéis, and R. Porcher, "Statistics in brief: The importance of sample size in the planning and interpretation of medical research," *Clinical. Orthopaedics Related Research*, vol. 466, pp. 2282–2288, 2008, doi: 10.1007/s11999-008-0346-9.
[24] H. Zhang *et al.*, "Exercise training modalities in prediabetes: a systematic review and network meta-analysis," *Front Endocrinol (Lausanne)*, vol. 15, Feb. 2024, doi: 10.3389/fendo.2024.1308959.
[25] M. Khalafi, M. E. Symonds, A. H. Maleki, M. H. Sakhaei, M. Ehsanifar, and S. K. Rosenkranz, "Combined versus independent effects of exercise training and intermittent fasting on body composition and cardiometabolic health in adults: a systematic review and meta-analysis," *Nutrition Journal*, vol. 23, no. 1, p. 7, Jan. 2024, doi: 10.1186/s12937-023-00909-x.
[26] Z. Huang, J. Li, Y. Liu, and Y. Zhou, "Effects of different exercise modalities and intensities on body composition in overweight and obese children and adolescents: a systematic review and network meta-analysis," *Frontiers in Physiology*, vol. 14, Jul. 2023, doi: 10.3389/fphys.2023.1193223.
[27] B. K. Ballenger, E. E. Schultz, M. Dale, B. Fernhall, R. W. Motl, and S. Agiovlasitis, "Health outcomes of physical activity interventions in adults with down syndrome: a systematic review," *Adapted Physical Activity Quarterly*, vol. 40, no. 2, pp. 378–402, Apr. 2023, doi: 10.1123/apaq.2022-0102.
[28] A. Theodoulou *et al.*, "Weight regain and mental health outcomes following behavioural weight management programmes: A systematic review with meta-analyses," *Clinical Obesity*, vol. 13, no. 3, Jun. 2023, doi: 10.1111/cob.12575.
[29] S. Peng, A. T. Othman, A. Z. Khairani, G. Zeng, Z. Xiaogang, and Y. Fang, "Effectiveness of pedometer- and accelerometer-based interventions in improving physical activity and health-related outcomes among college students: A systematic review and meta-analysis," *Digital Health*, vol. 9, Jan. 2023, doi: 10.1177/20552076231188213.
[30] J. A. Ligibel *et al.*, "Exercise, diet, and weight management during cancer treatment: ASCO guideline," *Journal of Clinical Oncology*, vol. 40, no. 22, pp. 2491–2507, Aug. 2022, doi: 10.1200/JCO.22.00687.
[31] T. Chen *et al.*, "Effects of aerobic exercise and resistance exercise on physical indexes and cardiovascular risk factors in obese and overweight school-age children: A systematic review and meta-analysis," *PLOS One*, vol. 16, no. 9, p. e0257150, Sep. 2021, doi: 10.1371/journal.pone.0257150.
[32] A. Bellicha *et al.*, "Effect of exercise training on weight loss, body composition changes, and weight maintenance in adults with overweight or obesity: An overview of 12 systematic reviews and 149 studies," *Obesity Reviews*, vol. 22, no. S4, p. e13256, Jul. 2021, doi: 10.1111/obr.13256.
[33] A. H. Bekhet *et al.*, "Benefits of aerobic exercise for breast cancer survivors: a systematic review of randomized controlled trials," *Asian Pacific Journal of Cancer Prevention*, vol. 20, no. 11, pp. 3197-3209, Nov. 2019, doi: 10.31557/APJCP.2019.20.11.3197.

BIOGRAPHIES OF AUTHORS

Cherkaoui Sidi Hassan is a pharmacist and Ph.D. student at Mohammed V University of Rabat and a member of the Research Team in Nutrition and Food Sciences Laboratory (UPR) at the Faculty of Medicine and Pharmacy Rabat. Former Chief of the Department of Physiology at the National Institute for Sport Research (INCS). He can be contacted at email: sidihassan_cherkaoui@um5.ac.ma.

Mouane Nezha is a professor, distinguished academic, and medical professional at Mohammed V University of Rabat, where she serves as a Professor and Head of the Pediatric Gastroenterology and Nutrition Department. She is also the Director of Research in Gastroenterology, Nutrition, and Metabolic Diseases, contributing significantly to the advancement of clinical and academic knowledge in her field. With extensive experience in pediatric health, she has published widely and actively participates in both national and international medical research initiatives. She can be contacted at email: nezhamouane@hotmail.com.