SYSTEMATIC LITERATURE REVIEW (SLR):THE INFLUENCE OF NUTRITION AND OBESITY ON AGING

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ABSTRACT
(1) Introduction: This review explores the relationship between nutrition, obesity, and aging, with a particular focus on the influence of obesity on the aging process. Obesity and aging are two conditions that have a major impact on human health, with the prevalence of obesity increasing with age. Both conditions contribute to the risk of insulin resistance, metabolic syndrome, and other chronic diseases that often occur in old age. Understanding the mechanisms of aging and the role of nutrition and weight control are key to slowing down the aging process and improving the quality of life among the elderly.
(2) Methods: This study used a systematic review method, with a literature search on databases such as Google Scholar, Sport and Health Science, Web of Science, and PubMed. The search was conducted on articles for the last 15 years in Indonesian and English. From the search results, 33,467 studies were found, and after the selection process, 30 studies that met the inclusion and exclusion criteria were further analyzed. Articles that did not meet the inclusion criteria or were indirectly related to the topic were excluded.
(3) Results: Analysis of the selected studies showed a strong association between obesity nutrition and aging. This emphasizes that a good diet plays an important role in slowing down aging and preventing age-related diseases. Good nutrition management, along with other health interventions, is an important strategy to maintain health and quality of life in old age. These results indicate a positive correlation between obesity, nutrition, and aging. Weight control and balanced nutrition have been shown to be important strategies in preventing age-related diseases and improving the quality of life of the elderly.
(4) Discussion: The findings from this study highlight the importance of appropriate nutrition interventions and obesity control in efforts to slow aging. The clinical implications of this study include the development of better health programs to reduce the risk of chronic diseases. In addition, further research is needed to explore the mechanisms of interaction between nutrition, obesity, and aging and to develop innovative intervention strategies to promote healthy aging.

INTRODUCTION

The prevalence of overweight and obesity has increased significantly worldwide. Recent data from the Global Burden of Disease Study (The GBD, 2017) shows that over the past 20 years, there has been an increase in the prevalence of obesity and the burden of disease associated with high body mass index (BMI) in 195 countries. In Indonesia, according to Basic Health Research data (Riskesdas, 2023), the prevalence of obesity reached 15.3%, up from 21.8% in 2018. This significant increase requires serious attention for effective prevention and treatment efforts due to its long-term impact on public health (RSPJ, 2024).

Adolescent obesity is a complex condition that is influenced by various factors, including genetics, diet, physical activity, sleep duration, social environment (such as peer and family influences), medication use, and hormonal imbalances. Irregular eating patterns, such as the habit of skipping breakfast and then overeating at lunch or dinner, are strongly associated with an increased risk of obesity (Turana & Handajani, 2021), (Jannah & Kusumaningrum, 2021). One eating disorder, Night Eating Syndrome (NES), is characterized by uncontrolled eating at night and has been shown to contribute to obesity (Noviasty et al., 2021); (Olejniczak et al., 2018).

The study by (Maryani et al., 2023) showed a significant correlation between Night Eating Syndrome, physical activity, diet, and obesity. Obesity contributes to increased visceral fat, which then affects hormonal balance, insulin resistance, and chronic inflammation, ultimately accelerating the aging process. Research by (Turana & Handajani, 2021) also revealed that obesity triggers the development of metabolic syndrome and increases the risk of cardiovascular disease.

In the context of aging, various physiological changes including decreased muscle function (sarcopenia), frailty, malnutrition due to excess or deficiency of nutrients, and decreased quality of

life are major issues (Zupo et al., 2023). According to (Bartlett et al., 2018), obesity exacerbates metabolic disorders with age and increases the risk of cardiovascular disease. In addition, changes in body fat distribution and metabolism that occur due to aging accelerate these degenerative processes (Jura & Kozak, 2016). Obesity also triggers oxidative stress that accelerates telomere shortening, while external factors such as UV exposure and smoking can damage elastin formation, thus accelerating skin tissue damage (Dewiastuti & Hasanah, 2016). Skin aging triggered by both internal and external factors, such as increased free radicals and UV exposure, causes damage to collagen and elastin, which eventually leads to wrinkles and other signs of aging (Dewiastuti & Hasanah, 2016); (Bartlett et al., 2018).

Good nutrition is of key importance in slowing down the aging process and managing obesity. Proper nutrition has a significant influence on various biological mechanisms associated with aging. A balanced, nutrient-rich diet can help regulate inflammation, known as “inflammaging”, and support cell health and mitochondrial function (Smith et al., 2023; Zhang et al., 2023). A Mediterranean diet, rich in fruits, vegetables, and healthy fats, has been shown to reduce the risk of cardiovascular and neurodegenerative diseases (Patterson et al., 2015).

Adequate protein intake is essential for maintaining muscle mass and strength, as well as preventing sarcopenia, a condition common in the elderly (NCC, 2022). In addition, a balanced diet plays a role in regulating blood sugar levels, reducing the risk of insulin resistance and type 2 diabetes, which often occur with age (Wilson & Manson, 2019). Intake of micronutrients such as vitamin D and calcium is also important for maintaining bone health and preventing osteoporosis in the elderly. Research shows that increasing fiber intake and reducing foods high in sugar and saturated fat can help manage weight and lower the risk of chronic diseases. Good nutrition can also improve the body's response to oxidative stress and inflammation, two major factors that contribute to the aging process (Frasca et al., 2017).

This study aims to: (1) summarize the latest findings in systematic reviews on the influence of obesity and nutrition on the aging process, (2) analyze existing knowledge gaps, and (3) provide a basis for further research in this area. The references used include systematic reviews of medical literature published in the last 15 years. The analysis of key research on this topic is expected to deepen the understanding of the impact of obesity and nutrition on the aging process. The results are expected to provide important insights into nutritional management and other health interventions to maintain health and quality of life in the elderly. Further research is needed to understand the long-term impact of nutrition interventions on aging and chronic disease risk.

METHODOLOGY

The method used in this study was a systematic review aimed at reviewing published and relevant literature on the relationship between obesity, nutrition, and aging. The literature search process was conducted through major scientific databases such as Google Scholar, Web of Science, PubMed, and Sport and Health Science using specific keywords such as “obesity”, “nutrition”, “aging”, and other related synonyms. Studies included in this analysis had to be published within the last 15 years (2010-2024) in peer-reviewed journals. Articles were selected that evaluated the correlation between obesity, nutrition, and aging in human adults or the elderly. Inclusion criteria included empirical studies focusing on the topic, while irrelevant studies and articles that only discussed indirect aspects of obesity or aging without a primary focus on their relationship were excluded from the review. Articles also had to be written or translated into English. The selection process was conducted systematically in three stages: evaluation of abstracts and titles, full reading of articles that met the criteria, and data extraction and analysis.

RESULTS

The study design of this systematic review aims to provide further explanation of the research results of the selected articles, which are listed in the following table:

Table 1
Systematic Review

No	Researchers	Sample	Methods	Results
1	(Jura & Kozak, 2016)	Journal publications published between 2002 and 2017	Used descriptive methodology to review the medical literature to identify similarities in mechanisms related to obesity and aging.	Age-related changes in body fat and metabolism can accelerate aging.
2	(Turana & Handajani, 2021)	107 elderly respondents aged ≥ 60 years in PUSAKA Kalideres West Jakarta	Using analytic descriptive research conducted in a cross-sectional manner. Univariate analysis with descriptive statistics, bivariate with chi-square test, and multivariate with Binary Logistic Regression.	Obesity has a significant relationship with sarcopenia with an obesity value of p=0.022.
3	(The GBD, 2017)	The sample data covered 68.5 million people using Global Burden of Disease (GBD) data.	Estimated the prevalence of overweight and obesity among children (<20 years) and adults between 1980 and 2015. Data analysis used the Global Burden of Disease (GBD) method to measure the burden of disease associated with high BMI in 195 countries from 1990 to 2015.	The prevalence and disease burden of high BMI are increasing globally. Between 1980 1980 and 2015, the prevalence of obesity increased rapidly in men aged 25-29 years in low-middle SDI countries, from 1.1% to 3.8%.
4	(Li et al., 2024)	Journal publications published between 2005 and 2023	Using experiments on animal models, in vitro studies, and modern biological techniques such as genetic manipulation. One study extended yeast lifespan by 82% with visual genetic circuits. This method aims to understand and slow down aging and increase healthy lifespan.	Age-related changes can be addressed with intervention strategies, such as calorie restriction, and improved sleep. Modern biological techniques in slowing aging and reducing age-related chronic diseases. For example, the use of “visual genetic circuits” extends the life of yeast by 82%.
5	(Gabrovec et al., 2018)	Journal publications published between 2002 and 2017.	Using descriptive methodology to review medical literature published in the last 15 years (2002-2017) and including peer-reviewed scientific journals.	Malnutrition increases the risk of fragility and its effects. The Mini Nutritional Assessment has good sensitivity/specificity for screening. Frail patients require Vitamin D supplementation. Mediterranean diet and protein intake of 1-1.2 g/kg body weight per day have been

No	Researchers	Sample	Methods	Results
				shown to be beneficial.
6	(Frasca et al., 2017)	Body mass index (BMI) data from 68 million people in 195 countries.	Using a systematic review of medical literature from multiple sources published between 2002-2017. The study covered various age groups and aimed to assess the increasing prevalence and burden of diseases associated with high BMI globally over the past 20 years.	Studies show a positive association between obesity in middle age and dementia, but the opposite in old age. Weight loss in middle age has a beneficial effect on the development of dementia. Nutrition plays a crucial role in influencing health and the aging process.

DISCUSSION

Obesity and Aging

Obesity is a condition that occurs due to an energy imbalance, where calorie intake exceeds energy expenditure, leading to the accumulation of excess fat in the body. This imbalance generally lasts for a long period of time, resulting in excessive accumulation of adipose tissue or fat. According to WHO cited by the Indonesian Ministry of Health (2018), obesity is the accumulation of excess fat that occurs due to an imbalance between energy intake and energy expenditure over a long period of time (Kemkes, 2024). Obesity is an increasing health problem globally. It is not only caused by a high-calorie diet, but also by lack of physical activity, lifestyle changes, and environmental factors that support sedentary behavior. The prevalence of obesity worldwide continues to increase and has become one of the main causes of various chronic diseases, such as type 2 diabetes, cardiovascular disease, hypertension, and several types of cancer (Widjaja et al., 2024). The management of obesity is important in preventing the development of related diseases. Therefore, approaches involving dietary modification, increased physical activity, and lifestyle changes are highly recommended for both the prevention and management of obesity.

Obesity is a major risk factor for metabolic diseases such as diabetes mellitus and cardiovascular disease (Widjaja et al., 2024). According to H.L. Blum Theory, the factors that cause obesity are as follows: 1) Environmental factors, including physical activity done only as a trend, the role of parents in controlling electronic use, diverse food choices, and dietary and lifestyle habits inherited from families; 2) Health service factors, such as extension activities that can affect the incidence of obesity; 3) Genetic factors, which include age, gender, parental fatness, and genetic mutations; and 4) Behavioral factors, including diet, lack of physical activity, and the habit of buying food outside (Saraswati et al., 2021). The health impacts of obesity include accelerated aging, cognitive impairment, insulin resistance, cancer, osteoarthritis, cholelithiasis, and increased risk of premature death. In addition, obesity can also reduce productivity and quality of life (Masrul, 2018). Obesity is a major risk factor in the aging process. It not only affects physical health through increased risk of diseases such as type 2 diabetes, hypertension, and osteoarthritis but also impacts quality of life and shorter life expectancy (Johnson & Thompson, 2022).

Aging is associated with various physiological changes, one of which is a decrease in the supply of oxygen (O_2) to tissues and a decrease in the partial pressure of oxygen (pO_2) within tissues. This condition is largely due to reduced vascularity, which impairs oxygen diffusion at the capillary level. When the oxygen supply decreases, tissues can develop hypoxia, a condition in which tissues do not get enough oxygen. This hypoxia, which is known to play a role in inflammation in obesity, also has the potential to accelerate the aging process, given that one of the main characteristics of aging is reduced oxygen supply to various body tissues (Valli et al., 2015). Obesity and aging have a complex relationship, where obesity can accelerate the deterioration of biological functions associated with age. Hypoxia that occurs in adipose tissue in obese individuals plays a role in the increase of chronic inflammation, or inflammaging, which is one of the main factors that exacerbate the

biological aging process. In addition, impaired metabolic conditions in obesity, such as insulin resistance and oxidative stress, further accelerate cellular aging. Studies have shown that obesity is becoming increasingly common in the elderly population, exacerbating the risk of health complications associated with aging. Data from the United States shows that the prevalence of obesity among the population aged 60 years and older reached 41.0% between 2015 and 2016 (Hales et al., 2017). This figure suggests that obesity in the elderly is a significant health concern and can worsen the quality of life and increase the risk of chronic diseases, such as heart disease, diabetes, and cognitive impairment, all of which are often associated with aging.

Nutrition and Aging

Aging is a complex process involving many interrelated molecular mechanisms and cellular systems. Phenotypically, biological aging accompanies a gradual decline in cellular function and systemic deterioration of tissues, which increases the risk of developing aging-related diseases (Li et al. 2024). Aging is a universal contributor to metabolic and health decline, and is a major risk factor for various diseases (Kirkland, 2013). Aging is associated with higher levels of pro-inflammatory cytokines, which alter insulin action. Insulin resistance, common in older adults is a major component of metabolic syndrome (Arum et al., 2014). Aging is an inevitable biological process and brings about significant changes in the human body, both physically and mentally. These changes include decreased organ function, increased risk of chronic diseases, and changes in body composition. Good nutrition and weight control are important to slow down the aging process and prevent health complications that often occur in the elderly (Li et al., 2024).

Nutrition plays an important role in supporting overall health and influencing the aging process. A healthy and balanced diet contributes greatly to slowing down the aging process through complex biological mechanisms. One of the main factors affecting aging is inflammation, a condition in which there is chronic low-grade inflammation that progresses gradually with age. This inflammation is systemic and often goes undetected, but it has a significant impact on health and plays a role in the development of many age-related degenerative diseases, such as heart disease, type 2 diabetes, arthritis, and Alzheimer's (Frasca et al., 2017). Inflammaging is caused by a combination of factors, including free radical accumulation, mitochondrial dysfunction, and over-activation of the immune system with age. Free radicals or reactive oxygen species (ROS) are formed as byproducts of cellular metabolism and can cause oxidative damage to DNA, proteins, and lipids. Over time, this damage accumulates and triggers a persistent inflammatory response. The condition is exacerbated by the body's decreased capacity to produce natural antioxidants, which fight free radicals.

The importance of nutrition in preventing inflammaging is not only limited to reducing inflammation but also to improving cellular function. A nutrient-rich diet supports healthy cell regeneration and improves autophagy mechanisms, the process by which the body's cells clear damaged components and recycle them to maintain optimal cell function. By supporting autophagy, proper nutrition can help extend cellular lifespan and reduce the risk of a build-up of damaged or dysfunctional cells, which can trigger inflammation and further aging. Thus, proper nutrition not only affects physical health but also plays a role in slowing down the biological aging process. A diet rich in antioxidants, anti-inflammatory compounds, and balanced macronutrients forms a fundamental strategy for mitigating inflammaging and maintaining optimal cellular function. This approach plays a crucial role in promoting healthspan extension and minimizing the risk of age-related diseases.

A diet rich in antioxidants, which are naturally found in various fruits and vegetables, is essential in fighting oxidative damage to cells. Oxidative damage occurs when there is an imbalance between free radicals and the body's ability to neutralize them. This process often increases with age, and if not controlled, can lead to premature aging and trigger degenerative diseases. Antioxidants work to neutralize these free radicals, reduce oxidative stress, and protect the body's cells from damage. The study by Zhang et al. (2023) showed that consumption of antioxidant-rich foods can reduce the level of oxidative damage to cells, which often occurs with age. Thus, the role of nutrients rich in anti-inflammatory and antioxidant substances is crucial in maintaining health as we age, helping to prevent chronic diseases, and slowing down the body's natural aging process.

Protein plays a crucial role in maintaining muscle health and strength, especially in preventing sarcopenia, a condition of decreased muscle mass often experienced by the elderly (NCC,

2022). Adequate protein intake is important for slowing the loss of muscle mass associated with aging, which in turn can improve mobility and quality of life in older people. Protein plays a role in supporting muscle protein synthesis, tissue repair, and maintaining optimal muscle function, which is crucial for the elderly to prevent physical weakness and improve balance and strength. In addition to protein, a diet rich in fiber and low in sugar also plays an important role in maintaining metabolic health in the elderly. Fiber can help control blood sugar levels and maintain digestive health, while low sugar consumption contributes to reducing the risk of insulin resistance and type 2 diabetes, which often occur with age (Wilson & Manson, 2019). By effectively controlling blood sugar levels, the risk of diabetes complications in the elderly can be reduced, as well as improving overall metabolic well-being.

The Mediterranean diet, known for its high content of fruits, vegetables, whole grains, and healthy fats such as olive oil, has been shown to provide long-term health benefits. Research suggests that this diet may lower the risk of cardiovascular and neurodegenerative diseases, such as Alzheimer's (Patterson et al., 2015). In addition, the balanced nutrition contained in the Mediterranean diet has been linked to improved cognitive function and prevention of cognitive decline that occurs with age. Thus, a healthy and regular diet, which includes adequate intake of protein, fiber, as well as healthy fats, plays a crucial role in slowing down the aging process. The right combination of nutrients not only helps maintain physical and mental health, but also improves quality of life in old age, prevents various chronic diseases, and prolongs healthy life expectancy.

CONCLUSIONS AND SUGGESTIONS

The conclusion of this systematic review is that aging is a complex process that is influenced by various factors, including nutrition, obesity, and inflammation. Obesity can accelerate the aging process through mechanisms such as epigenetic changes, mitochondrial dysfunction, and chronic low-grade inflammation. Good nutrition plays an important role in slowing down aging and preventing age-related diseases. Adequate intake of protein, and vitamin D, as well as healthy eating patterns such as the Mediterranean diet, can help reduce the risk of chronic diseases such as type 2 diabetes, heart disease, and cognitive impairment. Obesity and chronic inflammation, which are common in old age, contribute to various degenerative diseases and a general decline in health. While obesity can increase the risk of disease in both youth and old age, there is a complex link between obesity and cognitive decline. Good nutritional management, along with other health interventions, is an important strategy to maintain physical, cognitive, and emotional health in old age, thus reinforcing the concept of healthy aging.

Suggestions for future research cover several important areas to deepen the understanding of the relationship between nutrition, obesity, and aging. First, longitudinal studies are needed to evaluate the impact of nutritional interventions on aging and the risk of chronic diseases such as heart disease and diabetes. Second, further research is needed to understand the biological mechanisms linking obesity and inflammation with aging, especially in accelerating cellular aging. In addition, an evaluation of community-based nutrition programs is needed to understand their impact on biomarkers of aging. Additional research on specialized diets such as the Mediterranean diet is needed to explore their effects on health and aging. The use of technology such as wearable devices can assist in health monitoring and support more personalized nutrition interventions. These studies will hopefully lead to effective strategies for healthy aging and reducing the risk of chronic diseases in the elderly population.

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