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# PHYSIOLOGY AND PHYSIOPATHOLOGY OF ADIPOSE TISSUE IN ELDERLY

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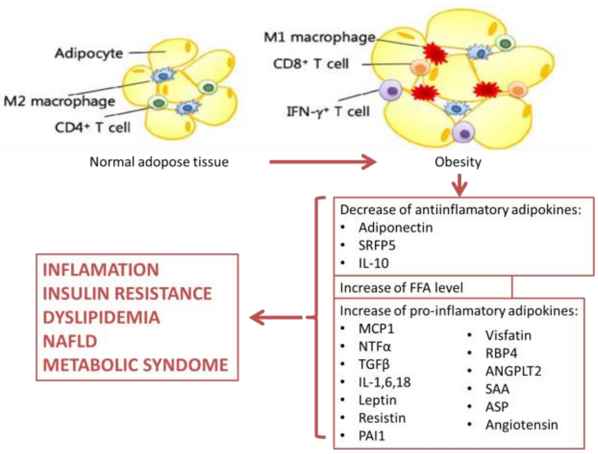
*Obesity represents an excessive weight increasing because accumulation of adipose tissue in subcutaneous layer and around viscera, which results from an imbalance between food intake and energy expenditure. In the last decades obesity become a worldwide health problem, its incidence increased with 44% in children and with 28% in adults. This phenomenon is frequently encountered in developed countries. Nowadays, another important health problem is population ageing. Obesity in elderly is the most important risk factor for diabetes, dyslipidemia, hypertension, atherosclerosis, sleep apnea syndrome and liver failure. Thus, understanding the mechanisms by which obesity is involved in physiopathology of other diseases is important. Changes in food intake, adipocyte's functions, metabolism and energy regulation occur during ageing and contribute to the normal fat and weight in elderly. The reduction of taste and smell acuity, common in elderly, induce delayed rate of absorption of macronutrients. Also, hormonal and metabolic changes disturb energy regulation. Additionally, all components of energy expenditure decrease with aging, in particular energy expenditure for physical activity and basal metabolic rate. Combined, these changes result in an increased susceptibility to energy imbalance (both positive and negative) in old age that is associated with deteriorations in health. The aim of these review was to synthesizes data on ageing-related changes in physiology and physiopathology of adipose tissue.*

*Key words:* obesity, adipose tissue, elderly, physiology

## INTRODUCTION

The adipose tissue is energy storing of the organism in the form of triglycerides, and it acts as an insulating layer, reducing heat loss through the skin[1]. The adipose tissue represents ~20% of the body weight in normal weight men and 28% in women[2,3]. Adipose tissue triacylglycerol content reflects energy balance. Because the body's capacity to store glycogen is finite and relatively small, long-term imbalances between energy intake and energy expenditure are reflected in a change in the amount of triacylglycerol stored in adipocytes. Adipocyte triacylglycerol content in turn reflects the balance between the processes of fat deposition and fat mobilization. It follows that these processes must be regulated in relation to whole body energy balance. Fat mobilization is readily stimulated by β-adrenergic activation[4,5]. However, the diurnal fluctuation in fat mobilization, which is high after an overnight fast but suppressed after meals, seems to depend more on changing insulin concentrations. Mature adipocytes develop from precursor cells known as preadipocytes by accumulating triacylglycerol. There has been debate as to the extent of cell turnover in human adipose tissue. Adipose tissue is arranged in discrete depots, and these depots have different relationships to health[4,6]. In general, accumulation of adipose tissue in the upper part of the body (abdominal obesity) is associated with detrimental effects on metabolic health and mortality[7], whereas lower-body fat accumulation is associated with protective effects especially after adjustment for upper-body fat and other risk factors for cardiovascular disease[8]. Upper-body fat accumulation usually reflects accumulation of both intra-abdominal fat and subcutaneous abdominal fat. In turn, intra-abdominal fat can be divided into that which is intraperitoneal and drains mostly into the hepatic portal vein, and retroperitonal depots such as perirenal. Although these are both sometimes referred to as "visceral fat," in this review we will reserve that term for the intraperitoneal depots as suggested by Mårin et al.[9]. The quantification of visceral fat volume depends on the imaging method, strategy, and site of measurement[10]. There is on-going debate about whether the adverse effects of abdominal obesity reflect particularly the accumulation of visceral fat, or whether subcutaneous abdominal fat (which is usually a considerably larger depot than visceral fat) is also involved. It has an important endocrine function, secreting adipokines (chemokines, cytokines). Many of the endocrine molecules are involved in inflammation and energy homeostasis. In the obese state, the adipocyte is integral to the development of obesity-induced inflammation by increasing secretion of various pro-inflammatory chemokines and cytokines. Many of this molecules, including monocyte chemoattractant protein (MCP-1), tumor necrosis factor (TNF-α), interleukin-1 (IL-1), interleukin-6 (IL-6) and interleukin-8 (IL-8), have been reported to promote insulin resistance. Furthermore, weight loss decreases macrophage infiltration and pro-inflammatory gene expression in adipose tissue in obese subjects. In addition to M1 macrophages, levels of multiple pro-inflammatory immune cells, such as interferon-γ (IFN-γ), T helper type 1 cells and CD8+ T cells, are increased in adipose tissue in obesity (Figure 1). In contrast, secretion of insulin-sensitizing adiponectin is reduced in obese subjects[3].




ANGPTL, angiopoietin-like protein; ASP, acylation-stimulating protein; IL, interleukin; MCP-1, monocyte chemotactic protein; NAFLD, nonalcoholic fatty liver disease; PAI-1, plasminogen activator inhibitor-1; RBP4, retinol binding protein 4; SAA, serum amyloid A; SFRP5, secreted frizzled-related protein 5; TGF-β, Transforming growth factor-β; TNF-α, tumor necrosis factor-α

**Figure 1** Pro-and anti-inflamatory adipokines in obesity (adaptated after [3]).

The changes of world demographics are very important, especially in developed countries. At the beginning of 20th century the percentage of elderly was 4% and increased at 13% currently[6]. In this context, is very important to understand the changes in physiology and metabolism of elderly, for better approaches for IMPROVING the quality of life and preventing late-life disabilities.

Roberts et al.[11] investigated whether older age is associated with altered energy intake responses to imposed overfeeding and underfeeding. The protocols attempt to examine experimentally the effects of variability in energy intake and energy balance within magnitudes that may occur during usual life. In the studies of Roberts et al., separate overfeeding and underfeeding studies were conducted, with young and elderly men enrolled in each protocol. The results showed that young men tended to lose all the excess weight they gained during overfeeding, and after underfeeding gained back more weight than they had lost during the experimental period, whereas elderly men lost only 29% of the excess weight gained during overfeeding and gained back only 64% of the weight lost during underfeeding[11,12].

There are well-documented age-related decreases of taste and smell sensitivity which increases the secretion of cholecystokinin and decrease of autonomic nervous system function[6,12]. Thus, delaying gastric emptying is very common in old persons[12-14]. The mechanisms of delaying gastric empting are increased phasic pyloric pressure waves in response to nutrients in the duodenum[15], impaired autonomic nervous system function (which is common in the elderly), and persistently elevated antral distension[16,17]. Delayng gastric emptying increases the levels of blood glucose, free fatty acids, insulin and glucagon. Additionally, a decrease of dietary variety occurs in context of dysphagia, specific diets for comorbidities. All those facts determine a disturbance in opioids and neuropeptide Y which reduce hunger and increase satiation[18]. Additionally, many social and medical changes associated with aging have been suggested to cause weight loss, such as poverty, bereavement, social isolation, poor dentition, chronic disease, and the use of multiple prescription medications[19,20]. In addition, depression has been suggested as an important cause of weight loss among the elderly, a finding that has been confirmed in an analysis of cohort data[21].

Basal metabolic rate (BMR) is the energy expenditure of an individual after a 12- to 14-h overnight fast during a period of mental and physical rest in a thermoneutral environment and reflects energy use of the body for such basic functions as maintenance of electrochemical gradients, transporting of molecules around the body, and biosynthetic processes[6]. BMR is responsable for 50-60% of total energy expediture. A decline in BMR with aging is well recognized. Keys et al.[22] documented an age-related decline of BMR with 1-2% per decade. The thermic effect of feeding, previously know as specific dynamic action, is the increase in energy expenditure above basal that is associated with consuming, digesting, and assimilating food[6]. Energy expenditure for physical activity and arousal, together with the BMR and the thermic effect of feeding, comprise an individual's total energy expenditure, which is equivalent to dietary energy requirements during weight maintenance[6].

## CONCLUSIONS

The age-related physiological modifications in adipose tissue are very important, but still uncompleted known. Obesity, which incidence is increasing, is associated with insulin resistance, dyslipidemia and nonalcoholic fatty liver disease. Thus, enlarged adipose tissue induce an unbalance of pro- and anti-inflamatory factors secreted by adipose tissue, which determine a chronic inflamation. Also, dysregulation of energy intake and energy expediture occures, inducing an unbalance in energy metabolism. Knowing that wight fluctuations in elderly is associated with increase risk of falls, frailty, delayed recovery, nutritional deficiency, premature death, practical interventions for prevention of weight and fat fluctuations in old age are anticipated here, based on emerging knowledge of the role of such factors as dietary variety, taste, and palatability in late-life energy regulation.

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