POSTER WEEK

Poster Week 25/2026

ABSTRACT BOOK

April 2026
20th – 24th

PEDAGOGICAL-SCIENTIFIC COMITEE

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Schedule **Poster Week 25/2026**

	2ª feira 20 April	3ª feira 21 April		4ª feira 22 April	5ª feira 23 April		6ª feira 24 April
08h - 09h							
09h - 10h	**Neurophysiology** 1º FC 12P *Joana Soares* **R 3.11**			**Systemic Pathological Anatomy II** 2º CBL 6P *Diana Martins* **R 1.3**			
10h - 11h		**Food Quality Certification** 2º SA 8P *Cristina Santos* **R 2.10**					
11h - 12h			**Electrocardiology II** 2º FC 15P *Joaquim Pereira* **R 3.4**				**Human Nutrition** 1º DN 12-15P *Bárbara Beleza* **Lab. Anatomy**
12h - 13h		**Pharmaceutical Technology and Galenic I Pharmacy I** 1º Farm 6P *Jorge Balteiro* **R 2.8**					
13h - 14h	**Lunch**						
14h - 15h		**Clinical Laboratory Immunohematology** 2º CBL 10P *Fernando Mendes* **R 3.4**			**Hearing Rehabilitation Technology** 2º Audio 5P *Carla Matos Silva* **R 1.3**		
15h - 16h							
16h - 17h	**Genetics and Epigenetics** 3º DN 8P *Célia A. Gomes* **R Zaida Chieira**				**Water Management and Quality II** 2º SA 8P *Cristina Santos* **R 1.3**	**Nutritional Policy** 3º DN 10P *João Lima* **R 2.4**	
17h - 18h							
18h - 19h							
19h - 20h							

LINKS TO POSTER FOLDERS

Folder	Disciplines	Year	Degree	Poster links
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25.2	Genetics and Epigenetics	3rd	Dietetics and Nutrition	https://photos.app.goo.gl/fHmAW19q5CTuKjyEA
25.3	Food Quality Certification	2nd	Environmental Health	https://photos.app.goo.gl/yP7TNxowS7ydBNwcA
25.4	Electrocardiology II	2nd	Clinical Physiology	https://photos.app.goo.gl/C3tnHmWDXxBRrVBC6
25.5	Technology and Galenic Pharmacy I	1st	Pharmacy	https://photos.app.goo.gl/zQ9tq4ve9jbtuhzP9
25.6	Clinical-Laboratorial Immunohemotherapy I	2nd	Biomedical Laboratory Sciences	https://photos.app.goo.gl/21eeGpxj8i3VyNG37
25.7	Systematic Pathologic Anatomy	2nd	Biomedical Laboratory Sciences	https://photos.app.goo.gl/emTLHAk9JBBRSq5BA
25.8	Hearing Rehabilitation Technologies	2nd	Audiology	https://photos.app.goo.gl/CoU7UohgqtTpLyyS6
25.9	Water Quality Management II	2nd	Environmental Health	https://photos.app.goo.gl/xsY5xjqbZpy7koLo7
25.10	Nutritional Policy	3rd	Dietetics and Nutrition	https://photos.app.goo.gl/7xmjbUKL9mhw3eUA7
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ABSTRACTS

HOW DIETS HIGH IN ULTRA-PROCESSED FOODS AFFECT BRAIN DEVELOPMENT

Afonso Oliveira, Ana Matos, Maria Monteiro, Lara Carreira

Instituto Politécnico de Coimbra, ESTeSC-Coimbra Health School, Fisiologia Clínica, Coimbra, Portugal

The increasing consumption of ultra-processed foods has become a major public health concern due to its impact on brain health and cognitive function. These foods are industrial formulations high in added sugars, saturated fats, salt, and additives, while low in fibre and essential nutrients. Common examples include soft drinks, sweets, fast food, and ready-to-eat meals. Their growing presence in modern diets raises concerns about effects on cognitive performance and brain structure.

This work was based on scientific databases such as PubMed. Evidence suggests that diets rich in ultra-processed foods may negatively affect cognition across life stages. In early childhood, when brain development is rapid, diet plays a crucial role. A study in China with children aged four to seven found that frequent consumption of sweets was associated with lower intelligence scores and reduced verbal comprehension, suggesting impaired cognitive development. During adolescence, dietary habits also influence neuropsychological functioning. Research in Spain showed that adolescents with higher consumption of ultra-processed foods had poorer emotion recognition, reduced attention, and less effective decision-making. In contrast, greater adherence to the Mediterranean diet was linked to better behavioural outcomes and improved executive functioning. In adulthood, long-term consumption of these foods has been associated with faster cognitive decline. A study of over 10,000 adults found greater deterioration in cognitive performance over time.

Neuroimaging neuroimaging studies indicate structural changes within brain regions related to reward and appetite regulation. Collectively, these findings underscore the importance of adopting healthier dietary patterns to promote optimal brain health and cognitive function.

Keywords: Ultra-processed foods, cognitive function, brain health, cognitive decline, dietary patterns, neurodevelopment.

Discipline: Neurophysiology

Professor: Joana Isabel Soares

Degree: Clinical Physiology

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AWAKE OR ASLEEP? THE NEUROPHYSIOLOGY BEHIND NARCOLEPSY

Andreia Pires, Leonor Almeida, Matilde Gomes

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Type 1 narcolepsy (NT1) is a chronic sleep disorder characterized by excessive daytime sleepiness and cataplexy. Its central pathophysiology involves dysfunction of the hypocretinergic system in the hypothalamus, which is crucial for stabilizing wakefulness and REM sleep. The loss of orexin-producing neurons, leading to reduced levels of hypocretin-1 in the CSF.

This reviewaims to characterize patients with NT1 and intermediate levels of hypocretin-1 in the CSF, relating these findings to clinical, neurophysiologicalneuroimaging and genetic data. Specifically seeking to analyze microglial density and genetic variants associated with narcolepsy, as well as their impact on sleep parameters. Also, we intend to correlate, anxiety and depression levels with this condition.

Based on a search conducted in PubMed, it was found that patients with NT1 and intermediate levels of hypocretin-1 exhibit a heterogeneous phenotype, with cataplexy associated with sleep-onset REM periods, a dynamic potentially influenced by genetic variations. Additionally, neuroimaging revealed changes in the insula, lingual gyrus, calcarine, and postcentral gyrus, some of which correlate with higher anxiety and depression levels, and sleep disturbances such as sleep duration, latency and efficiency. These results suggest dysregulation of sleep architecture and the stability of these patients' sleep–wake cycle.

In summary, NT1 is a complex neurophysiological disorder, primarily associated with orexin deficiency and hypothalamic changes. The clinical diversity, along with the observed brain and genetic changes, highlight the complexity of the disease. Orexin agonists represent a promising therapy targeting underlying neurophysiological mechanisms that may contribute to better future approaches.

Keywords: Narcolepsy Type 1, Neurophysiology, Orexin, Hypocretin, Hypothalamus, REM Sleep.

Discipline: Neurophysiology

Professor: Joana Isabel Soares

Degree: Clinical Physiology

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EARLY-LIFE TRAUMA AS A DETERMINANT OF NEURODEGENERATIVE DISEASE SUSCEPTIBILITY

Afonso Matos, Iris Gomes, Laura Fernandes, Matilde Francisco

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Introduction: Adverse childhood experiences, such as physical, emotional, or sexual abuse, neglect and household dysfunction, have been increasingly recognized as long-term risk factors for both physical and mental health.

Methods and materials: The selected studies analyzed 1,223 American adults aged 65 to 96 years, over 150,000 participants from the UK Biobank, and approximately 75,528 women from the Nurse's Health Study II. Early-life trauma was quantified using composite ACE (Adverse Childhood Experiences) scores, covering categories such as physical and emotional abuse, neglect, and household dysfunction. AI was used to find the most significant and rigorous scientific articles.

Results: Individuals exposed to trauma equivalent to level 4 or higher on an ACE score have a probability up to 1.6 times higher of showing cognitive decline. The physiological mechanisms involved in these situations are chronic

activation of the hypothalamic-pituitary-adrenal (HPA) axis and the trigger of persistent systemic inflammation state, which acts as a mediator in the deterioration of episodic memory. Neuroimage and biomarker research suggests that early trauma shapes white matter integrity and alters the levels of proteins such as glial fibrillary acidic protein (GFAP) and neurofilament light (NfL), affecting the resistance of vulnerable structures like the hippocampus and the amygdala.

Conclusion: In the final analysis, early trauma acts as a "biological scar" that compromises the cognitive reserve, emphasizing the urgency of preventive interventions and childhood stress mitigation policies to reduce the global burden of neurodegenerative diseases in aging.

Keywords: Neurodegeneration, childhood trauma, cognitive decline, hypothalamic-pituitary-adrenal axis, cognitive aging.

THE INMPACT OF MUSIC ON CHILD DEVELOPMENT

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Music has been recognised as a crucial factor in neurodevelopment in preschool-aged children, influencing synaptic plasticity and brain architecture. This work aims to understand the mechanisms by which musical exposure and participation modulate cognitive and motor functions in children.

This review is based on PubMed articles investigating the impact and influence of rhythmic and melodic stimulation on child development. The methodologies employed include enriched musical environments and structured musical interventions, with a focus on optimising executive function, cognitive flexibility, and fine motor coordination.

Based on the articles, it has been demonstrated that musical stimulation, particularly in pre-school ages, has contributed to an increase in grey matter density in the frontal gyri, enhancing working memory, and in the left intraparietal sulcus, contributing to improved fine visuomotor coordination. Furthermore, it was shown that musical stimuli also boost inhibitory control, with a noticeable difference between children with and without this type of stimulation, as individuals with musical influence tend to possess greater cognitive flexibility and an enhanced ability to maintain focus.

Overall, music establishes itself as an enriching neurophysiological modulator, indispensable for optimised brain development in childhood. Its capacity to influence synaptic plasticity and brain architecture underscores the importance of musical integration in early developmental contexts.

Keywords: Music; early childhood; neurodevelopment; executive function; motor coordination; cortical remodelling; synaptic plasticity.

EFFECTS OF PHYSICAL EXERCISE ON NEURAL DEVELOPMENT AND NEUROPLASTICITY

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Physical activity (PA) is associated with molecular, structural, and functional brain changes reflecting neuroplastic processes throughout the lifespan. Recent neurophysiological evidence highlights specific pathways, such as the modulation of mature brain-derived neurotrophic factor (mBDNF), which promotes neuronal survival, growth, plasticity, synaptogenesis, and the structural segregation of large-scale brain networks. This study synthesizes evidence mapping how exercise-induced plasticity evolves from preschool age to biological maturity.

This targeted narrative review selected five key articles from PubMed utilizing advanced neurophysiological markers to map this trajectory across specific developmental milestones.

In preschoolers, cognitively enriched PA is significantly more effective than standard physical education in fostering motor competence and executive functions. Biochemically, acute vigorous exercise induces a marked elevation of mBDNF across children, adolescents, and adults, correlating with lactate levels. Longitudinally, PA at age 10 predicts specific volumetric increases in the amygdala and hippocampus by age 14. Finally, childhood exercise strongly indicates adult response inhibition by facilitating the modular segregation of the Frontoparietal and Default Mode networks.

The neurophysiological benefits of PA contribute to a structural and functional "legacy". Early-life movement "sculpts" the brain's architecture, providing a foundation for superior adult cognitive control. Furthermore, regular aerobic exercise in maturity preserves hippocampal integrity and metabolic health. Notably, exercise frequency markedly impacts mBDNF production, whereas cardiovascular fitness measures (VO_2max) do not. These findings advocate for vigorous, cognitively challenging exercise as a primary non-pharmacological tool for optimizing neuroplasticity and cognitive reserve across the lifespan.

Keywords: BDNF; Hippocampus; Executive Function; Exercise; Structural Neuroplasticity

Discipline: Neurophysiology

Professor: Joana Isabel Soares

Degree: Clinical Physiology

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Edition 25/2026

SLEEP DEPRIVATION AND THE UNIVERSITY BRAIN: COGNITIVE CONSEQUENCES

Filipa Fontainhas, Julia Henn, Laura Casaca

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Introduction: Sleep deprivation is common among college students and has gradually been associated with poor performance in various cognitive fields that can affect academic achievement. Reduced sleep quality and duration can impact essential learning processes such as attention, memory, and executive functions.

Methods: This study analyzes results from six recent empirical studies that, using experimental methodologies, examined the relationship between sleep deprivation and cognitive performance. These studies involved 1297 students who underwent periods of sleep restriction, followed by neuropsychological tests, experimental tasks, and questionnaires such as CANTAB, MoCA, TMT, and PSQUI. The analysis focused on identifying the main neurophysiological mechanisms associated with sleep deprivation, particularly alterations in the activity and connectivity of cortical regions involved in cognitive control, with an emphasis on the prefrontal cortex, through magnetoencephalography and cognitive tasks. Neuroimaging techniques were also employed to assess changes in brain functional connectivity associated with sleep loss.

Results: The results demonstrate that sleep deprivation negatively affects cognitive processes. Decreases in attention and reductions in working memory capacity were observed. In college students, reduced sleep quality is associated with impulsivity, inattention, and a reducing in learning performance and visuospatial memory. Neurocognitive evidence indicates that even a single night without sleep can alter functional connectivity in brain networks associated with executive control and reduce the accuracy of metacognitive judgments.

Conclusion: The analysis shows that sleep deprivation impairs attention, working memory, and executive functions. Given its prevalence among university students, promoting healthy sleep habits is crucial for academic success.

Keywords: Sleep deprivation, College students, Prefrontal cortex, Executive functions, Academic performance

Discipline: Neurophysiology

Professor: Joana Isabel Soares

Degree: Clinical Physiology

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DRUG ADDICTION: HOW ADDICTION CHANGES THE BRAIN

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Drug addiction is a complex phenomenon involving neurobiological, behavioral, and psychological changes. Development of addiction is associated with progressive changes in brain circuits responsible for reward, emotion, and cognitive control.

Materials and methods: This work is based on an analysis of scientific articles from PubMed that address drug dependence from different perspectives, including neurobiological studies, theoretical models, and investigations into consumption patterns. The studies were analyzed comparatively with the aim of identifying the main brain mechanisms involved in the development of dependence.

Previous work indicated that substances of abuse increase dopamine release in the reward system, making brain less responsive to natural rewards and more sensitive to drug-related stimuli. A study of individuals with alcohol use disorder found increased connectivity between circuits related to negative emotionality and craving, and decreased connectivity between executive control and reward, with more pronounced changes in individuals with greater clinical severity. In 31 abstinent heroin-dependent individuals, drug-related cues increased activation in the left dorsolateral prefrontal cortex, insula, orbitofrontal cortex, and bilateral thalamus. Furthermore, a more intense initial activation of the left dorsolateral prefrontal cortex was associated with a greater decrease in craving after six months of abstinence.

Addiction is caused by alterations in the dopaminergic reward system. Over time, these adaptations decrease the ability to control consumption and increase the likelihood of compulsive and reactive behaviors. The development of better prevention, diagnosis, and treatment strategies for substance use disorders can be facilitated by an integrated understanding of these mechanisms.

Keywords: brain, dopamine, reward system, drug addiction

WHAT HAPPENS IN THE BRAIN DURING SLEEP PARALYSIS?

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Sleep paralysis is a parasomnia associated with rapid eye movement (REM) sleep, frequently accompanied by sensations of suffocation, fear, and hallucinations. It is characterized by a temporary inability to perform voluntary movements at sleep onset or upon awakening, despite preserved consciousness.

This study uses PubMed as its primary source and aims to understand the morphological changes in the brain and to identify which populations are most affected.

When two-dimensional measurements were performed, it was observed that partially ineffective regulatory mechanisms appear to be compensated by an increase in the length of the cerebellar vermis. The pontine regions are also implicated in REM sleep and the maintenance of REM atonia, including the sublaterodorsal nucleus (SLD), which, when artificially stimulated, has been shown to induce muscular paralysis. In the thalamus, the medial pulvinar there's no statistically significant differences were detected in transverse diameters.

Furthermore, when subjected to electroencephalography (EEG), the EEG spectrum during wakefulness and REM sleep was found to be intermediate in the alpha, theta, and delta frequencies, whereas beta frequencies showed no differences between sleep paralysis and normal REM sleep.

Studies show some discrepancies, but when sample sizes are expanded, a higher prevalence of sleep paralysis is found in women compared to men. Women also tend to use mobile phones more before bedtime and experience higher levels of stress during episodes.

Thus, it was possible to observe the incidence of sleep paralysis both at the population level and at the neuroanatomical level.

Keywords: Parassomnia, REM sleep, Sleep paralysis

Discipline: Neurophysiology

Professor: Joana Isabel Soares

Degree: Clinical Physiology

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NEURODEVELOPMENTAL OUTCOMES OF CEREBROVASCULAR INJURY IN EARLY LIFE

Francisca Barraca, Lara Cunha, Matilde Carvalho

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Brain injuries, such as ischaemic stroke (IS) and cerebral sinus venous thrombosis (CSVT), can occur during the early stages of life. Although they are rarer in children, they are highly likely to occur in the neonatal period, a time of significant adaptation and vulnerability for developing structures. At this stage, the brain is more sensitive to oxygen deprivation, as it is still learning to regulate blood flow.

Thus, ischaemic interruption not only affects immediate function but also causes permanent consequences regarding the maturation of neural circuits, and compromises motor and cognitive development. This occurs because the injury disrupts the way neurons connect as the child grows. They also vary depending on clinical conditions, such as congenital heart disease or coagulation disorders, as well as the location and extent of the injury. These may occur more frequently in the middle cerebral artery, where the basal ganglia and the corticospinal tract are involved, increasing the severity of this type of injury.

Many of these children, following their injuries, live with cerebral palsy, epilepsy, visual impairments, as well as learning difficulties and attention deficits. These problems may only become more apparent at school age, when academic demands increase. Therefore, children exposed to these types of events must receive proper support aimed at improving their rehabilitation and ensure they have a stable environment in which they can grow up safely. Long-term multidisciplinary support is essential to ensure their independence.

Keywords: Paediatric stroke, brain injury, neurodevelopment, neurological sequelae, early diagnosis

GUT-BRAIN CONNECTION: IMPACT ON ALZHEIMER'S DISEASE

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Introduction: The gut–brain axis is increasingly recognized as a key modulator of Alzheimer's disease (AD), with gut microbiota dysbiosis linked to neuroinflammation, protein aggregation, and cognitive decline. Human studies across the AD continuum, including mild cognitive impairment (MCI), demonstrate consistent taxonomic, functional, and metabolomic alterations in intestinal microbiota.

Methods and materials: The reviewed cohorts combined 16S rRNA or metagenomic sequencing of fecal samples with plasma and fecal metabolomics, neuropsychological assessment, neuroimaging and fluid biomarkers, and lifestyle data, particularly Mediterranean diet adherence.

Results: AD and MCI subjects show reduced microbial diversity, depletion of butyrate producing, anti inflammatory genera, and enrichment of pro inflammatory taxa, accompanied by altered short chain fatty acids, bile acids, and other neuromodulatory metabolites. These microbiota and metabolite signatures correlate with amyloid and tau pathology, structural brain changes, systemic inflammation, and worse cognition, while multi omics models delineate pathways linking microbiota, fecal metabolites, brain structure/function, cognitive performance. Higher adherence to a Mediterranean lifestyle is associated with a more favorable microbial profile and better cognitive outcomes, supporting diet mediated modulation of the microbiota–gut–brain axis.

Conclusion: Overall, the studies define a peripheral signature of AD characterized by specific microbiota and metabolite disturbances that interact with inflammatory and neurodegenerative mechanisms. The gut microbiome emerges as a promising source of biomarkers for early detection and staging of AD and as a therapeutic target through dietary, probiotic, or other microbiota directed interventions.

Keywords: Gut–brain axis, gut microbiota, mild cognitive impairment, neuroinflammation, Mediterranean diet

Discipline: Neurophysiology

Professor: Joana Isabel Soares

Degree: Clinical Physiology

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THE NEURAL BALANCE BETWEEN EMOTION AND RATIONALITY IN MORAL CHOICE

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The understanding of human morality has been revolutionized by evidence showing that moral judgment deeply depends on emotional processes, observable at multiple levels of analysis. Integrating findings from neuroanatomy, psychopathology, and computational modeling, the studies converge on a hierarchical model of moral functioning. At the neural level, the amygdala-ventromedial prefrontal cortex (VMPFC) circuit proves fundamental: the amygdala processes immediate emotional reactivity, while the VMPFC integrates these experiences to simulate future scenarios, enabling the emotional anticipation that guides moral decision-making. This architecture is consistent with the Somatic Marker Hypothesis, which posits that adaptive decisions depend on bodily emotional signals.

Disruption of this circuit, as observed in psychopathy, produces distinct and even opposite moral patterns. Challenging the traditional view that psychopathy favors cold utilitarianism, different facets of the disorder predict specific moral profiles: affective deficits are associated with deontological decisions motivated by indifference, while interpersonal and antisocial traits relate to utilitarian choices, particularly in contexts of spontaneous emotional processing.

At the computational level, the drift diffusion model reveals that emotion dominates moral evaluation through dissociable pathways: positive emotion accelerates evidence accumulation toward moral judgment, reflecting the integrative function of the VMPFC; negative emotion reduces the decision threshold for immoral judgment, increasing impulsivity in a process that echoes amygdala reactivity. Together, the studies demonstrate that morality emerges from the dynamic balance between emotion and cognition, anchored in specific neural circuits whose integrity is a necessary condition for adaptive ethical functioning.

Keywords: amygdala-vmpfc circuit, somatic marker hypothesis, drift diffusion model, physchopathy, dynamic balance between e motion and cognition.

METABOLIC SYNDROME

Alexandra Pires, Beatriz Santos, Martim Lacerda, Natasha Fonseca, Renata Nóbrega

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Metabolic Syndrome (MS) is a complex condition resulting from the interaction between environmental and genetic factors; sedentary lifestyle, obesity, and poor dietary habits are the main risk factors. It has a high global prevalence, reaching approximately 40% in individuals over 55–60 years old and is more common in women. In Europe, prevalence ranges between 18%-30%. Diagnostic criteria require three of five conditions: abdominal obesity, hypertension, elevated fasting glucose, high triglycerides and low HDL-C.

Genetics plays a significant role in MS development. Several studies have identified associations with chromosomes 2, 3, 11, 13, and 15, linked to traits such as insulin resistance, obesity, type 2 diabetes (T2DM), hypertension, and leptin levels. Several candidate genes, including *ADIPOQ* (Chr3), *AGT* (Chr1), *APOE* (Chr19), *GNB3* (Chr12), *FTO* (Chr16) and *LEP* (Chr7) have also been associated with the metabolic components of the syndrome.

The accumulation of visceral adiposity promotes the release of inflammatory cytokines (IL-6 and TNF-α) and increased C-reactive protein, leading to chronic inflammation. Oxidative stress increases ROS and leptin while decreasing adiponectin. Insulin resistance reduces muscle glucose uptake and alters lipid metabolism, increasing triglycerides and LDL-C while decreasing HDL-C. These changes increase the risk of T2DM and cardiovascular diseases.

Although evidence is limited regarding improved outcomes when treating MS as a whole, addressing its individual risk factors significantly reduces overall risk. Treatment mainly focuses on lifestyle interventions, including healthier diet, weight loss, regular physical activity, pharmacological therapy and, if necessary, surgery.

Objective: To analyze the prevalence, genetic factors, phenotypic changes, and treatments of MS. Understanding the main risk factors is also essential in order to raise awareness about the importance of nutritional intervention as a form of prevention.

Keywords: Metabolic Syndrome, Nutritional Intervention, Genetics, Pathophysiology

NUTRIGENOMICS IN AGEING AND DIETARY PREFERENCES

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Nutrigenomics is a field of science that studies the interaction between nutrients, dietary patterns, and the genome, with the aim of understanding how diet can influence gene expression and biological processes related to aging and the risk of chronic diseases. This approach allows us to understand how certain nutrients can modulate physiological pathways linked to aging, including oxidative stress, DNA repair, and metabolic signaling, producing effects that depend on individual genetic profiles.

Dietary patterns rich in bioactive compounds, such as polyphenols and omega-3 fatty acids, can positively influence the expression of genes associated with longevity, reduced inflammation, and energy metabolism. Among the genes involved, *FOXO3*, *SIRT1*, and *APOE* stand out, which are related to longevity, energy metabolism, and response to oxidative stress. At the same time, associated with sensory perception, *TAS2R38* and *TAS2R16* stand out, presenting single nucleotide polymorphisms (SNPs) that can affect taste perception, digestion, and nutrient metabolism, modulating food preferences and distinct physiological responses to similar diets. During aging, physiological changes also occur, such as decreased taste and smell, lower secretion of digestive enzymes, and changes in the gut microbiota, factors that can compromise adequate nutrient intake and increase the risk of nutritional deficiencies. Thus, nutrigenomics offers a promising approach for personalized nutritional interventions that optimize nutrition and promote healthy aging.

Objective: To analyze the relationship between nutrigenomics, aging, and food preferences, highlighting the role of genetic variations and sensory factors in food choices.

Keywords: Nutrigenomics; aging; gene expression; food preferences.

Discipline: Genetics and Epigenetics

Professor: Célia Alcobia Gomes

Degree: Dietetics and Nutrition

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POMPE DISEASE: UNDERSTANDING THE DISEASE AND ITS GENETIC TRANSMISSION

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Pompe disease (PD), also known as glycogen storage disease type II, is a rare, chronic, progressive autosomal recessive disorder due to *GAA* gene mutations on chromosome 17q25. This gene encodes the enzyme acid alpha-glucosidase (GAA), which is responsible for the degradation of glycogen into glucose within lysosomes. PD has an estimated incidence of approximately 1 in 40,000 individuals which can vary widely among different ethnic groups. Mutations in the *GAA* gene allows glucose to build up to toxic levels in lysosomes which leads to lysosomal enlargement, dysfunction, and eventual rupture. In addition to lysosomal damage there are mechanisms that contribute to muscle fiber disruption and progressive muscular impairment. PD is classified into infantile-onset Pompe disease (IOPD) and late-onset Pompe disease (LOPD), which differ in age of onset, severity, and organ involvement. IOPD typically appears within the first months of life and is characterized by hypotonia, motor delay, feeding difficulties and cardiorespiratory problems. LOPD generally manifests after infancy and is mainly associated with progressive proximal muscle weakness and respiratory insufficiency, usually without severe cardiac involvement. Diagnosis is based on reduced GAA enzymatic activity detected in blood samples and confirmed by molecular genetic testing identifying pathogenic variants in the *GAA* gene. Treatment mainly relies on enzyme replacement therapy with recombinant human GAA, which slows disease progression, although long-term clinical decline may still occur. In addition to this therapy, the approach is based on symptomatic and supportive treatment. In LOPD, high-protein diets combined with exercise may improve muscle strength and quality of life, though evidence remains limited.

The aim of this work is to describe the fundamental aspects of PD.

Keywords: Pompe Disease, *GAA* gene, Genetic Disorder, Enzyme Replacement Therapy

GENETICS AND OBESITY

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Obesity and weight regulation disorders are determined by the combined effects of genetics and the environment. The rising prevalence of obesity is a global health problem among adults, children, and adolescents, as it increases the risk of various diseases, including type 2 diabetes (T2D), hypertension, cardiovascular disease, dyslipidemia, and certain types of cancer. Obesity has been increasing globally, already affecting more than two billion adults, and projections indicate a continued rise.

Genetics accounts for approximately 40% to 77% of the variation in BMI, highlighting an important role in disease risk. From a genetic perspective, obesity can be polygenic—the most common form, resulting from the combination of various genetic variants—or monogenic, caused by rare mutations in a single gene involved in the regulation of appetite and energy metabolism.

The main genes involved in the leptin-melanocortin pathway, which regulate appetite and satiety, are *LEP*, *LEPR*, *POMC*, and *MC4R*, located on chromosomes 7 (7q31.3), 1 (1p31.3), 2 (2p23.3), and 18 (18q21.32), respectively. Changes in these genes disrupt appetite and energy expenditure, increasing the risk of obesity.

The main phenotypic change associated with obesity is an increase in body mass and adipose tissue resulting from an imbalance between energy intake and energy expenditure, leading to the storage of this energy as fat. This contributes to metabolic changes that affect the body's normal functioning and increase susceptibility to metabolic comorbidities. As nutritionists, understanding genetic factors and integrating them with dietary guidance is essential to mitigate the prevalence and consequences associated with obesity.

Objective: To understand genetic factors associated with obesity.

Keywords: Obesity; Genetics; Polygenic; Monogenic;

TYROSINEMIA TYPE 1

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Tyrosinemia Type 1 (HT1) is a rare hereditary metabolic disorder caused by a deficiency of the enzyme fumarylacetoacetate hydrolase, which catalyzes the final step of tyrosine degradation. The *FAH* gene, located on chromosome 15q23–q25, contains several pathogenic mutations that impair enzyme activity. The disease follows an autosomal recessive inheritance pattern and has an estimated prevalence of approximately 1 in 100,000 births. Deficiency of fumarylacetoacetate hydrolase leads to the accumulation of toxic metabolites, including fumarylacetoacetate, maleylacetoacetate and succinylacetone, which accumulate mainly in hepatocytes and renal tubular cells, resulting in progressive liver and kidney damage. The main organs affected are the liver, kidneys and peripheral nervous system, and the disease may manifest from the neonatal period to adulthood, presenting acute, subacute or chronic forms. The most severe complications include liver failure, cirrhosis and hepatocellular carcinoma. Diagnosis is based on the detection of succinylacetone, considered a specific biochemical marker of the disease, and on molecular confirmation of mutations in the *FAH* gene. Current treatment includes nitisinone, combined with nutritional intervention based on the restriction of tyrosine and phenylalanine, the use of specific formulas, and regular monitoring of nutritional status. In addition, expanded newborn metabolic screening has enabled early diagnosis in pre-symptomatic stages, significantly improving patient prognosis and quality of life. This work aims to review the genetic basis, pathophysiological mechanisms, clinical manifestations, diagnostic approaches and therapeutic strategies associated with Tyrosinemia Type 1.

Keywords: Tyrosinemia Type 1; *FAH* gene; Tyrosine metabolism; Genetic; Nutrition

Discipline: Genetics and Epigenetics

Professor: Célia Alcobia Gomes

Degree: Dietetics and Nutrition

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GAUCHER DISEASE: MOLECULAR MECHANISMS AND EPIGENETIC REGULATION

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Gaucher disease (GD) is an autosomal recessive lysosomal storage disorder that illustrates the complex interaction between genetics and epigenetics in cellular metabolism. Caused by mutations in the *GBA1* gene, located on chromosome 1 (1q22), which result in a deficiency of the enzyme glucocerebrosidase, it leads to the toxic accumulation of glucocerebroside. Clinically, three types of GD are distinguished: type 1 (non-neuronopathic), type 2 (acute neuronopathic), and type 3 (chronic neuronopathic).This accumulation results in multisystemic manifestations such as hepatosplenomegaly, cytopenias and, specifically in the neuronopathic variants (Types 2 and 3), progressive neurological decline.

Despite its monogenic aetiology, clinical variability in GD suggests a strong influence of epigenetic alterations, including profound microRNA (miRNA) dysregulation. These epigenetic changes contribute to cellular stress, mitochondrial dysfunction, and neurodegeneration in neuronopathic forms, while also creating a pro-oncogenic signature that predisposes Type 1 GD patients to neoplasms

Epigenetic signatures are emerging as promising biomarkers for prognosis and cancer risk. While standard enzyme replacement therapy (ERT) has limitations in reversing these abnormal marks, future prospects like pharmacological chaperones and CRISPR/dCas9 epigenome editing represent promising strategies to restore homeostasis

Ultimately, this study analyses the molecular mechanisms of GD, emphasizing the genetic-epigenetic intersection and the potential of miRNAs as innovative biomarkers and therapeutic targets.

Keywords: Gaucher Disease; Glucocerebrosidase; Epigenetics; MicroRNAs; Genetics.

CLASSICAL HOMOCYSTINURIA

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Homocystinuria is a chronic inherited metabolic disease caused, in most cases, by mutations in the *CBS* gene (chromosome 21), which cause a deficiency of the enzyme cystathionine beta-synthase and consequent accumulation of homocysteine. In Portugal, it is expected that 1 in 450,000 births will present the pathology. Transmission is autosomal recessive, with the disease occurring only when two mutated copies of the gene are inherited.

Our research was based on sources from the Portuguese Association for Phenylketonuria and Other Metabolic Disorders (APOFEN) and the European Network and Registry for Homocystinurias and Methylation Defects (EHOD).

People with homocystinuria lack the enzyme that metabolizes homocysteine, and excess methionine leads to the formation of other amino acids, namely homocystine, whose high levels are detected in the blood and urine. The diagnosis is made through the “heel prick test” (neonatal screening) or by analyzing amino acids in the blood/urine.

Treatment is based on a low-protein diet with methionine restriction, since this amino acid is present in all protein foods, and aims to prevent the accumulation of toxic metabolites. In addition, supplementation with vitamin B6, vitamin B12, folic acid, or betaine is used to optimize the remaining metabolic pathways and ensure proper growth and development.

Homocystinuria highlights the importance of early diagnosis to prevent serious complications. Neonatal screening and targeted treatment—based on methionine restriction and adequate supplementation—allow the accumulation of homocysteine to be controlled and significantly improve the prognosis of affected individuals.

The objective of this study is to investigate the inherited metabolic disorder: Classic Homocystinuria.

Keywords: Homocystinuria, methionine, *CBS* gene, heredity

Discipline: Genetics and Epigenetics

Professor: Célia Alcobia Gomes

Degree: Dietetics and Nutrition

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GENETIC AND DIETARY DETERMINANTS OF HYPERTENSION

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High blood pressure is one of the leading causes of cardiovascular morbidity and mortality worldwide and is considered a multifactorial disease resulting from the interaction between genetic and environmental factors. Among modifiable factors, diet plays a central role in regulating blood pressure, influencing physiological mechanisms such as electrolyte balance, endothelial function, and renin-angiotensin system activity. On the other hand, among non-modifiable factors of genetic origin, advances in nutrigenetics have been fundamental. In recent years, this field has allowed for a detailed understanding of how variations in the human genome can modify the individual response to certain nutrients, contributing to interindividual differences.

Recent scientific evidence identifies multiple gene-nutrient interactions associated with blood pressure regulation. A comprehensive review reported gene-nutrient interactions involving approximately 20 genes and 31 single-nucleotide polymorphisms related to changes in blood pressure. Among the most frequently studied genes are *ACE* (rs4646994) and *AT1R* (rs5186), both components of the renin-angiotensin system, which is fundamental to blood pressure homeostasis. Sodium intake emerges as one of the most investigated dietary factors, demonstrating an association with salt sensitivity in individuals carrying certain genetic polymorphisms.

In addition, dietary patterns rich in fruits, vegetables, and specific micronutrients may have beneficial effects on blood pressure in certain genetic profiles, highlighting the potential of personalized nutrition.

Objective: To explore the interaction between genetic and dietary factors in hypertension, highlighting the relevance of nutrigenetics for understanding individual variability in dietary response and for developing more targeted nutritional strategies for the prevention and management of the disease.

Keywords: Hypertension; Nutrigenetics; Gene-nutrient interaction; Genetic polymorphisms; Diet.

Discipline: Genetics and Epigenetics

Professor: Célia Alcobia Gomes

Degree: Dietetics and Nutrition

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HEREDITARY FRUCTOSE INTOLERANCE

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Hereditary Fructose Intolerance (HFI) is an inborn error of metabolism exemplifying a profound gene-environment interaction. Asymptomatic until dietary diversification, the disease is triggered by fructose ingestion, potentially causing fatal hepatorenal failure. Understanding its genotypic basis and metabolic regulation is crucial for early diagnosis and nutritional intervention.

HFI results from mutations in the *ALDOB* gene, located on the long arm of chromosome 9 (9q31), which lead to the inactivation of the aldolase B enzyme. It is a pathology with an autosomal recessive inheritance pattern. Upon weaning, dietary fructose induces toxic fructose-1-phosphate accumulation. This traps inorganic phosphate (Pi) and depletes cellular ATP, inhibiting vital pathways like glycogenolysis and gluconeogenesis. Consequently, patients suffer severe hypoglycemia, vomiting, and progressive hepatorenal damage. The gold standard diagnosis is molecular screening, resorting to liver biopsy in inconclusive cases.

Treatment requires the lifelong exclusion of fructose, sucrose, and sorbitol, including hospital care. Prophylaxis in newborn siblings is crucial until molecular confirmation. Strict dietary adherence rapidly reverses symptoms, but minor transgressions cause severe lesions. This restriction requires vitamin C and folic acid supplementation. Folic acid appears to boost the activity of glycolytic enzymes, including aldolase B, conferring metabolic benefits. Future perspectives highlight gene therapy and ketohexokinase (KHK) inhibitors as promising curative approaches to restore metabolic tolerance.

This study analyzes the molecular mechanisms of HFI, focusing on the *ALDOB* gene deficiency, its genetic regulation, and the gene-environment interaction, while addressing molecular diagnosis and nutritional treatment approaches.

Keywords: Fructose, genetics, metabolism, hereditary disease, *ALDOB* gene.

Discipline: Food Quality Certification

Professor: Cristina Santos

Degree: Environmental Health

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THE IMPORTANCE OF CERTIFICATION CONSUMER PERCEPTION

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This study investigated consumers' perception of the importance of food certification and its influence on trust and purchasing decisions. In a context of globalization of supply chains and increasing consumer demand for transparency and food safety, certification emerges as a crucial tool to build trust, although the multiplicity of labels can create confusion. The main objectives were to analyze consumers' level of knowledge about certification labels, the degree of trust in certified products, the willingness to pay a higher price, and the influence of clarity of information on labels. The adopted methodology combined a literature review with a quantitative study, through an online questionnaire applied to a sample of consumers. The results revealed a duality in consumers' perception. Although the majority search for certification labels only occasionally or rarely (56.3%), and familiarity with the different types of labels is moderate (41.1% do not consider themselves familiar), confidence in certified products is high (88.3% trust them a lot or moderately). In addition, a significant percentage (76.5%) considers that certified products are safer and of higher quality. However, the importance attributed to certification in the purchase decision is, for the majority (52.9%), low.

The discussion suggests that certification acts as a reinforcement of the perception of safety and quality, even if it is not the main decision factor for all consumers. The gap in knowledge and the difficulty in identifying specific labels limit the effectiveness of certification as a communication tool. It is concluded that, despite the high confidence and perception of quality, it is imperative to improve communication and consumer education about food certification to maximize its impact and empower consumers to make more informed choices. It is suggested that future research delve into the factors that influence the active search for labels and the impact of different communication strategies.

Keywords: certificacion, globalization, consumers' perception

SUSTAINABLE PACKAGING AND FOOD SAFETY

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The present study analysed the role of sustainable packaging in food safety within the context of food quality certification. Food packaging was described as essential for protecting, preserving, and maintaining the sensory and nutritional characteristics of food throughout the supply chain.
The methodology was based on a literature review and documentary analysis, with 8 research sources consulted, including studies by Costa (2015), the European Food Safety Authority (2023), Delfino (2013), Fonte *et al*. (2021; 2025), Laranjo *et al*. (2021), Castillo *et al*. (2025), and European legislation such as Regulation (EC) No. 1935/2004.
The results showed that packaging played a fundamental role as a barrier against physical, chemical, and microbiological contamination, requiring strict compliance with safety regulations. There was also a growing development of sustainable solutions, including biodegradable materials, edible packaging, and active packaging with antioxidant and antimicrobial properties, which demonstrated potential to extend food shelf life and reduce environmental impact.
It was concluded that adopting sustainable packaging requires balancing food safety and environmental sustainability, with technological innovation, sustainable design, and appropriate regulation being essential to ensure safe and efficient solutions.

Keywords: sustainable packaging, food safety, sustainability, food quality

LEVEL OF KNOWLEDGE AND BEST PRACTICES IN CERTIFICATION

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Certification in the food sector is often associated with improved quality, trust, and organizational credibility, although its technical significance may not be fully understood by the general public. The objective of this study was to assess the Portuguese population's level of knowledge and perceptions regarding certification and best practices related to food quality and safety, combining a literature review with the administration of a questionnaire. Methodologically, a targeted review of Portuguese scientific and technical-scientific sources was conducted, and an online questionnaire was administered to participants residing in Portugal (aged 18 and older). The results show low self-assessed knowledge regarding food certification; only 10.5% of respondents claim to have knowledge on the subject. However, in comparison, they demonstrate a high appreciation for compliance with and updating of procedures (78.9%), as well as a positive perception of the impact of certification on quality and institutional image (63.2%). It is concluded that there is a discrepancy between conceptual knowledge and a favorable attitude, suggesting a need to strengthen literacy and provide public clarification regarding certification, standards, and accreditation.

Keywords: certification, accreditation, good practices, food safety, Portugal

THE IMPORTANCE OF HACCP IN THE FOOD INDUSTRY

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Food safety is an essential factor in protecting public health and ensuring the quality of food produced and marketed. In this context, the HACCP system (Hazard Analysis and Critical Control Points) plays a fundamental role in the food industry, as it allows the identification, evaluation, and control of hazards associated with food throughout all stages of the production process.

The present work aimed to analyze the importance of implementing the HACCP system in the food industry, highlighting its contribution to the prevention of food-related risks, the improvement of product quality, and compliance with current legislation. The methodology used was based on a bibliographic review of various scientific and institutional sources related to food safety and the application of the HACCP system.

The results obtained show that the application of this system enables companies in the food sector to adopt a preventive approach to food safety management, significantly reducing the likelihood of contamination and foodborne diseases. In addition, the implementation of HACCP contributes to the improvement of production processes, strengthens consumer confidence, and increases the competitiveness of companies in the food market. Eight reference sources were used in this work.

It was concluded that the HACCP system is an essential tool for ensuring high levels of food safety and product quality, playing a decisive role in protecting public health and in food quality certification.

Keywords: food safety, HACCP, food industry, food quality, risk prevention

THE CONTRIBUTION OF CERTIFICATION TO THE RESTAURANT INDUSTRY

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Food certification has played a relevant role in ensuring food safety and protecting public health, particularly in the restaurant sector, where hygiene failures and improper food handling may lead to foodborne diseases. In this context, the present study aimed to analyse the contribution of food certification in food service establishments, highlighting its importance in promoting food safety, ensuring compliance with sanitary standards, and strengthening consumer confidence.

To carry out the study, a bibliographic review on certification and food safety was conducted, complemented by the application of a questionnaire to the general population. The sample consisted of 122 participants with different sociodemographic characteristics.

The results showed that 44.3% of respondents perceived the risk of contracting foodborne diseases when eating out as moderate, while 21.3% considered it high and 22.1% low, with only a small percentage classifying it as very high. Street food (54.1%) was identified as the type of establishment associated with the highest risk. Regarding food certification, most participants associated it with audits and inspections (62.3%), good hygiene practices (52.5%), and the HACCP system (49.2%). A significant proportion also considered that certification contributes to risk reduction, improved hygiene, and increased consumer trust.

It can be concluded that food certification is widely recognised as an important tool for enhancing food safety and consumer confidence in the restaurant sector, highlighting its contribution to the prevention of foodborne diseases

Keywords: food certification, food safety, restaurants, HACCP, public health

CERTIFICATION OF AGRICULTURAL PRODUCTS: QUALITY, INSURANCE AND SUSTAINABILITY

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Agricultural product certification plays a crucial role in ensuring quality, food safety, and sustainability in the agricultural sector. This study aimed to assess the level of knowledge and adoption of certification systems among agricultural producers, as well as to identify the main challenges associated with their implementation. A questionnaire was conducted among farmers and agricultural technicians to collect data on practices, perceptions, and difficulties related to certification processes.

The results indicate a high level of awareness and recognition of the importance of certification and Good Agricultural Practices (GAP). However, the effective adoption rate remains low, particularly among small-scale farms. The main barriers identified include bureaucracy, complex legal requirements, and lack of technical training. Additionally, some uncertainty exists regarding the economic benefits of certification, such as improved market access, insurance advantages, and product value.

Despite these challenges, most respondents show willingness to invest in certification in the future. It is concluded that strengthening technical support, training, and simplifying administrative procedures are essential to increase certification adoption and enhance the competitiveness and sustainability of the agricultural sector.

Keywords: agricultural certification; food safety; sustainability; good agricultural practices; competitiveness

TORSADE DE POINTES

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Introduction: Torsade de pointes (TdP) is a form of rare polymorphic ventricular tachycardia, which is characterized by a morphology of the QRS complex that varies from beat to beat. It can reverse itself spontaneously, but may cause ventricular fibrillation or even be fatal.

Methods and materials: Studies analyzed 22 case reports and 103 case series of patients of both genders diagnosed with Torsade de Pointes. Most of these patients had no structural heart disease, coronary disease, or family history of cardiovascular diseases.

Results: Trigger electrocardiographic findings for Torsade de Pointes were ventricular extrasistoles with short coupling interval, and ventricular extrasistoles with longer QRS, with normal QT interval in all patients. The origin of triggers are in the Purkinje fibers and the right ventricular outflow tract. Torsade de pointes originating in Purkinje fibers is associated with ventricular extrasistoles with shorter coupling intervals and most of these TdP evolves to ventricular fibrillation. However, the TdP caused by long coupling intervals and wider QRS originated in the right ventricular outlet tract. For both TdP triggers the most common symptoms throughout the study were syncope and cardiac arrest.

Conclusion: Variations of ventricular extrasistoles with coupling intervals of Torsade de Pointes predominantly affect patients with structurally normal hearts and preserved QT interval. Diagnosis is based on the duration of QRS to identify whether ventricular extrasystoles have short or long coupling intervals, in order to predict their origin. Triggers in the Purkinje fibers have shorter coupling and a higher risk of ventricular fibrillation compared to those of the right ventricular outflow tract that have longer coupling intervals.

Keywords: Arrhythmias, Sudden Death.

CHARACTERISTICS AND FUNCTION OF HUMECTANTS IN PHARMACY

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Humectants are hygroscopic substances used in Galenic Pharmacy with the ability to attract and retain water, helping to prevent dehydration and maintain the stability of pharmaceutical formulations. They are considered excipients, meaning components that accompany the active substance and contribute to the preparation, preservation, and administration of medicines.

These compounds are particularly important in liquid and semi-solid pharmaceutical forms, such as creams, ointments, gels, solutions, and syrups, as they help maintain the consistency of the formulation, prevent crystallization, and ensure its homogeneity. In topical preparations, they also contribute to skin hydration and improve the texture and application of the product.

Among the most commonly used humectants are organic compounds such as glycerin, propylene glycol, sorbitol, polyethylene glycols, and sodium lactate, which show good tolerability and compatibility with other formulation components.

Despite their advantages, their use requires some caution. Excessive concentrations may cause irritation or make the formulation sticky, and in very dry environments, some humectants may draw water from the skin itself. In addition, it is important to ensure proper storage conditions to prevent the development of microorganisms.

In summary, humectants play an important role in Galenic Pharmacy because they contribute to the stability, hydration, and quality of pharmaceutical formulations.

Keywords: Hygroscopic properties; Skin hydration; Humectants in pharmacy; Moisture retention.

Discipline: Technology and Galenic Pharmacy I

Professor: Jorge Balteiro

Degree: Pharmacy

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CONTROLLED FLOCCULATION OF PHARMACEUTICAL SUSPENSIONS

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Pharmaceutical suspensions are heterogeneous dispersed systems composed of insoluble solid particles dispersed in a liquid vehicle. These formulations are commonly used when drugs exhibit low water solubility or instability in solution. However, their physical stability may be compromised by particle sedimentation, a phenomenon described by Stokes' law, which can lead to the formation of a compact sediment known as caking. Controlled flocculation is a strategy used to minimize this problem by promoting the formation of loosely bound particle aggregates called flocs. These flocs settle more rapidly but form a porous sediment that can be easily redispersed. This process depends on the balance between attractive and repulsive forces acting between particles and can be influenced by factors such as zeta potential and the use of flocculating agents. Sedimentation volume is commonly used as a parameter to evaluate the degree of flocculation in suspensions. Despite its advantages, excessive flocculation may lead to the formation of very large flocs and compromise the stability of the formulation.

Keywords: Pharmaceutical suspensions; Physical stability; Controlled flocculation; Sedimentation volume; Particle caking.

USE OF PARABENS IN GALENIC FORMULATIONS

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Parabens are esters of p-hydroxybenzoic acid, widely used as preservative agents in the cosmetic, personal hygiene, pharmaceutical and food industries, where their main function is to ensure the microbiological stability of formulations and prevent the growth of microorganisms. Methylparabens, ethylparabens, propylparabens and butylparabens are the most common types, whose primary role is to extend product shelf life. Parabens alter cell membrane permeability, impairing nutrient transport necessary for microbial growth, and they interfere with enzymatic activity and cellular metabolism. Parabens differ mainly in the length of their side chain; they are colourless crystals or crystalline powders, weak acids, and they vary in their solubility in water and oil. Recently, concerns have emerged regarding the use of parabens as preservatives in cosmetics, and therefore in the EU only preservatives listed in the regulation may be used. Although regulatory authorities consider parabens safe within permitted concentrations, some studies indicate that they may also cause skin irritation, interfere with the hormonal system, and potentially contribute to cancer development. Pharmacy professionals play an essential role in selecting preservatives, assessing compatibilities, performing stability tests, and ensuring proper labelling. Parabens are used in galenic formulations such as semisolid, oral, topical and ophthalmic preparations. Regulatory bodies such as the EMA have restricted long chain parabens, driving the ‘paraben free’ trend, which also carries some associated risks. Overall, parabens are effective and economical preservatives when used according to safety standards.

Keywords: Parabens; Preservatives; Microbiological stability; Regulatory safety; Galenic formulations.

Discipline: Technology and Galenic Pharmacy I

Professor: Jorge Balteiro

Degree: Pharmacy

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FLOCCULATION AND CREAMING IN EMULSIONS

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The stability of emulsions is essential in sectors such as the pharmaceutical, cosmetics and food industries. Two phenomena that contribute to the loss of this stability are flocculation and cream formation. Emulsions are systems consisting of two immiscible phases, such as oil and water, where one is dispersed in the other in the form of droplets. Even with the use of emulsifiers, these mixtures tend to separate over time.

Flocculation involves the approach and aggregation of droplets from the dispersed phase, forming flocs held together by weak forces, without fusion between them. Although the droplet size remains unchanged, the emulsion becomes cloudier and less homogeneous, reducing stability and promoting subsequent stages of separation.

Creaming occurs when droplets or flocs migrate to the top of the emulsion due to the density difference between the phases, resulting in a concentrated layer. This phenomenon is typical of oil-in-water emulsions and, unlike coalescence, is generally reversible through agitation. The rate of creaming depends on the droplet size, viscosity and the density difference between the phases.

To minimise flocculation and cream separation, various formulation strategies can be employed: appropriate selection of emulsifiers, control of pH, ionic strength and temperature, reduction of droplet size through efficient homogenisation, increasing the viscosity of the continuous phase, and the use of thickeners or stabilisers. Maintaining appropriate storage conditions also contributes to more stable, homogeneous and effective emulsions, ensuring the quality and safety of pharmaceutical, cosmetic and food products.

Keywords: Emulsion stability; Flocculation; Creaming; Emulsifiers

MULTIPLE EXCIPIENTS FOR THE DIRECT COMPRESSION OF POWDERS.

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The use of multiple excipients in formulations intended for direct compression is essential to optimize powder behavior and ensure tablet quality. Direct compression requires raw materials with good flowability, adequate compressibility, and the ability to form homogeneous blends—characteristics that many active pharmaceutical ingredients do not naturally possess. Therefore, combining excipients with complementary functions allows the adjustment of properties that are critical for processing and for the performance of the dosage form.

Glidants and anti-caking agents improve powder flow by reducing interparticle forces, facilitating filling operations and machine feeding. Excipients such as microcrystalline cellulose, lactose, and phosphates contribute to compressibility and cohesion, enabling the formation of tablets with appropriate hardness and low friability. Lubricants prevent friction with metal surfaces, avoiding defects and ensuring proper tablet ejection.

Blend uniformity is another critical aspect, especially when the drug is present in small amounts or has a distinct particle size distribution. Diluents and bulking agents help distribute the active ingredient consistently, reducing unit-to-unit variability. In fast-disintegrating formulations, disintegrants and soluble excipients promote water penetration and efficient drug release. Additionally, stabilizers control moisture and protect the active ingredient during storage.

Although it offers significant advantages, the use of multiple excipients requires a deep understanding of their interactions, as inappropriate combinations may compromise stability, processing, or formulation costs.

Keywords: Excipients; Direct compression; Flowability; Stability

Discipline: Technology and Galenic Pharmacy I

Professor: Jorge Balteiro

Degree: Pharmacy

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TYPES OF DRY POWDER MIXERS FOR PHARMACEUTICAL USE

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Dry powder mixers are essential in the pharmaceutical industry, especially in the production of solid dosage forms such as tablets and capsules. Selecting the right equipment is crucial to ensure mixture homogeneity, prevent segregation and comply with good manufacturing practices. Common equipment includes V-blenders, double-cone mixers, 3D mixers and square-cone mixers. These systems work by rotating the vessel containing the powders or granules. In V-blenders and doble-cone mixers, the movement lifts and drops the material, creating a cascading effect that promotes homogeneous, low- shear mixing. They are suitable for large batches and are easy to clean, reducing cross-contamination risks. Three-dimensional mixers improve on these designs by moving the material along multiple axes, increasing efficiency and reducing mixing time.

Ribbon mixers consist of a horizontal trough with helical blades that move the powder from the center to the ends and back, combining macro-mixing and micro-mixing. They are versatile and can handle powders with different properties, as well as small amounts of liquids.

Conical screw mixers use a vertical screw that lifts the material and lets it fall, generating gentle three-dimensional movement ideal for fragile or segregation-prone powders.

High-shear mixers operate at high speed and are used for mixing, wet granulation and producing emulsions or suspensions.

Bin blenders (IBC mixers) use portable containers that serve both as mixing vessels and transport units, minimizing losses and contamination.

The choice of mixer depends on material characteristics, production volume, process requirements, and is key to ensuring the quality and uniformity of pharmaceutical products.

Keywords: Powder mixers; Homogeneity; Pharmaceutical industry

THE FORSSMAN BLOOD ANTIGEN: FROM MOLECULAR BASIS TO TRANSFUSION PRACTICE

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The Forssman blood group antigen (FORS system, 031) is a glycosphingolipid that belongs to the globoside family, and it is a heterophile antigen (Ag), that is chemically defined by the presence of a terminal N-acetylgalactosamine residue (α1,3-GalNAc). In humans, the expression of this Ag is typically absent due to the functional inactivity of the *GBGT1* gene, which encodes the Forssman synthase enzyme responsible for its biosynthesis.

However, when rare activating mutations exist, predominantly missense variants, they can restore enzymatic function, resulting in the synthesis of the globoside Gb4 into the Forssman Ag and its subsequent expression on the erythrocyte membrane, leading to the rare Fs+ phenotype.

From an immunological perspective, most "Forssman-negative" individuals have natural anti-Forssman antibodies (Ab), primarily of the IgM class, with a high capacity to activate the complement cascade. This characteristic has significant clinical relevance in transfusion medicine, since Ag-Ab incompatibilities can trigger severe acute hemolytic reactions.

Currently, the identification of Fs+ individuals depends on a certain combination of specialized serological techniques and molecular diagnostic methods, such as Next-Generation Sequencing. These advancements have been crucial for the accurate identification of rare erythrocyte Ag. This has led to a better understanding of blood group diversity, increasing transfusion safety and improving the monitoring of patients with rare phenotypes.

Keywords: Forssman antigen, *GBGT1*, glycosphingolipids, rare phenotypes, blood groups

THE JOHN MILTON HAGEN BLOOD GROUP: FROM MOLECULAR BASIS TO TRANSFUSION PRACTIC

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The John Milton Hagen (JMH, ISBT 026) blood group system consists of six high-prevalence antigens (Ag) and is determined by the semaphorin 7a protein. This glycoprotein on the surface of red blood cells (RBC) is encoded by the *SEMA7A* gene located on chromosome 15. Mature Sema7a has an important role in cell fusion, cell migration, immune response-stimulating cytokine production and transmission in neurons. Single-nucleotide changes in the *SEMA7A* gene account for the other JMH antigens (Ag). JMH1 is most notable because a transient depression of the Ag occurs and anti-JMH may develop. In most cases of JMH Ag variation, anti-JMH antibodies (Ab) are usually positive.

The JMH-negative population accounted for approximately 2.3% in Caucasians of Northern Europe. The inherited JMH-negative blood group is characterized by amino acid sequence variation of Sema7a and can be alloimmunized against missing epitopes to produce anti-JMH alloantibodies.

Acquired JMH-negative RBC are caused by the weakening or deletion of the JMH Ag, which mainly occurs in elderly female patients. On the other hand, the inherited JMH-negative phenotype is derived from mutations in the *SEMA7A* gene.

During blood transfusion, anti-JMH autoantibodies in acquired JMH-negative patients might further lead to the occurrence of hemolysis events. Blood transfusion of JMH-positive RBC in JMH-negative patients with a positive anti-JMH alloantibody can lead to an acute hemolytic transfusion reaction, causing intravascular or extravascular hemolysis, which leads to the aggravation of anaemia symptoms and threatens the lives of patients.

Keywords: Semaphorins, blood group antigens, blood transfusion, glycoproteins, alloantibodies

Discipline: Clinical-Laboratory Immunohemotherapy I

Professor: Fernando Mendes

Degree: Biomedical Laboratory Sciences

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THE CD59 BLOOD ANTIGEN: FROM MOLECULAR BASIS TO TRANSFUSION PRACTICE

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CD59 is a cell membrane glycoprotein, expressed on a wide range of cells, including red blood cells (RBC), where it protects cells from complement-mediated lysis by preventing the formation of the Membrane Attack Complex through its interaction with complement components C8 and C9. In addition to its regulatory function, CD59 is also a clinically relevant RBC antigen in immunohematology, with potential implications for transfusion compatibility.

The analysis of the CD59 antigen uses flow cytometry to quantify protein expression and immunohematological/molecular tests to distinguish between congenital deficiency and acquired deficiency. The CD59 analysis includes functional assays of complement-mediated lysis and alloantibody screening. Samples required include whole blood in EDTA (for immunophenotyping) and serum or plasma (for antibody detection).

Alterations in CD59 expression are associated with pathological conditions such as Paroxysmal Nocturnal Hemoglobinuria (PNH), a disorder characterized by defects in GPI-anchor synthesis leading to partial or complete deficiency of CD59 on RBC. This deficiency results in increased susceptibility of RBC to complement-mediated hemolysis, causing chronic intravascular hemolysis.

From a transfusional perspective, CD59 deficiency does not typically involve antibody-mediated incompatibility; however, the underlying complement dysregulation contributes to ongoing hemolysis, which may limit the effectiveness of transfusion therapy. In such cases, the use of complement-inhibitory treatments has been shown to reduce hemolysis and improve patient outcomes.

This work highlights the molecular and immunohematological role of CD59 for improved transfusion management, supporting the identification of complement-mediated hemolysis and better clinical decision-making, particularly in PNH and congenital deficiency cases.

Keywords: CD59, Membrane Attack Complex, Paroxysmal Nocturnal Hemoglobinuria, complement-mediated hemolysis, transfusion

THE DOMBROCK BLOOD GROUP: FROM MOLECULAR BASIS TO TRANSFUSION PRACTICE

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The Dombrock (Do) blood group system has gained increasing attention due to its molecular complexity and clinical relevance in transfusion medicine. The principal antigens of this system are DoA and DoB, while advances in molecular biology have enabled the identification of three additional high-frequency antigens: GyA, Hy, and JoA. The codominant expression of these antigens.

is associated with genetic variations in the *ART4* gene. Molecular characterization of this gene allows reliable antigen prediction and facilitates the identification of rare phenotypes that may not be detectable through conventional serological methods.

The distribution of DOA and DOB alleles varies across geographic regions, reflecting population genetic diversity. Phenotypic variability within the Dombrock system is influenced by evolutionary mechanisms, including natural selection and migration patterns. The main antibodies identified, anti-DoA and anti-DoB, are typically of the IgG class and generally do not fix complement. Despite being considered moderately immunogenic, these antibodies are clinically significant because they can cause accelerated erythrocyte destruction and are associated with delayed hemolytic transfusion reactions.

Detection of Dombrock antibodies remains challenging due to the limited availability of specific antisera and the possibility of negative results in routine serological testing. Consequently, molecular genotyping has emerged as a valuable alternative to traditional phenotyping, improving antigen prediction, donor–recipient compatibility, and overall transfusion safety. Among the known molecular markers, the 793A/G polymorphism represents an important indicator for phenotype determination within the Dombrock blood group system.

Keywords: Dombrock Blood Group; Antibody; Antigen

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THE CHIDO/RODGERS BLOOD GROUP: FROM MOLECULAR BASIS TO TRANSFUSION PRACTICE

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The Chido/Rodgers (Ch/Rg) blood group system is recognized as the seventeenth blood group system, distinguished by the unique localization of its antigens. Unlike most blood group antigens, Chido and Rodgers antigens are not intrinsic components of red blood cell (RBC) membranes but are carried on the fourth component of complement (C4), a plasma protein that adsorbs onto RBC surfaces. The C4 protein originates from activation of the classical complement pathway, initiated by the binding of C1 to immunoglobulin G (IgG) or immunoglobulin M (IgM). This process activates C1r and C1s proteases, leading to cleavage of C4 into two fragments: C4a, the smaller anaphylatoxin fragment, and C4b, the larger fragment involved in complement cascade amplification.

Serological and biochemical studies demonstrate that plasma expressing both Ch and Rg antigens contains both C4 fragments, whereas $Ch^{+}Rg^{-}$ plasma is associated predominantly with C4b and $Ch^{-}Rg^{+}$ plasma with C4a. These findings support the localization of Ch and Rg antigenic determinants on products derived from the C4 locus. To date, nine antigens have been identified within this system: Ch1–Ch6, Rg1, Rg2, and WH. Commonly detected antibodies include anti-Rg1, anti-Rg2, anti-Ch1, anti-Ch2, and anti-Ch3, which can be identified through several serological techniques.

Clinically, Ch/Rg antibodies are generally considered insignificant in RBC transfusion practice, as they have not been associated with hemolytic transfusion reactions. However, rare severe anaphylactic reactions have been reported following transfusion of plasma-containing components, including fresh frozen plasma and platelet concentrates. Additionally, C4 deficiency linked to the Ch/Rg system has been associated with autoimmune disorders, particularly systemic lupus erythematosus, as well as Graves' disease and rheumatoid arthritis.

Keywords: Chido/Rodgers; blood group; C4; plasma; antigens

Discipline: Clinical-Laboratory Immunohemotherapy I

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THE AUGUSTINE BLOOD GROUP: FROM MOLECULAR BASIS TO TRANSFUSION PRACTICE

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The Augustine blood group, a relatively recent system, was officially recognized by the International Society of Blood Transfusion (ISBT) in 2016, as the 36th human blood group system, although the At^a had already been identified in 1967. It is defined by 4 antigens, of which AUG1, AUG2, and AUG4 are highly prevalent, while AUG3 is particularly rare.

The Augustine system is of great clinical importance in both blood transfusions and pregnancy. Among several clinical challenges, anti-AUG2 antibodies can cause haemolytic transfusion reactions in cases of donor-recipient incompatibility, whereas the anti-AUG3 antibody has been associated with severe haemolytic disease in the fetus and new-born (HDFN).

Although extremely rare, AUG1-negative individuals may develop anti-AUG1 antibodies after exposure to the AUG1-positive antigen, either through blood transfusion or fetomaternal exposure during pregnancy, potentially leading to HDFN.

The expression of AUG antigens is directly associated with the Equilibrative Nucleoside Transporter 1 (ENT1), a membrane protein responsible for the balanced transport of nucleosides, encoded by the *SLC29A1* gene. Mutations or variants in *SLC29A1* gene can alter the structure or expression of ENT1, leading to the absence or modification of AUG antigens on the surface of red blood cells, characterizing the various phenotypes.

When it comes to rare phenotypes such as AUG-null, transfusion management requires international collaboration to identify rare donors, alongside molecular genetic techniques for accurate identification.

Advances in molecular understanding and detection of the Augustine system have therefore contributed to improving the safety and efficacy of transfusions for patients with rare phenotypes.

Keywords: Keywords: Augustine, ENT1, *SLC29A1 gene*, AUG antigens, Haemolytic Transfusion Reactions

THE VEL BLOOD GROUP: FROM MOLECULAR BASIS TO TRANSFUSION PRACTICE

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The Vel blood group system is a rare but clinically important red cell antigen system because of its strong immunogenicity and the difficulty of identifying Vel-negative individuals. It was first recognized in 1952, when a Vel-negative patient with anti-Vel antibodies developed an intravascular hemolytic reaction after receiving incompatible Vel-positive red blood cells. Since then, the system has been recognized as one of the most significant minor blood group systems in transfusion medicine.

The Vel blood group antigen is a high-frequency red cell antigen found in more than 99% of the population, while the Vel-negative phenotype is extremely rare, and because of this high prevalence, Vel-negative individuals are at risk of alloimmunization after exposure to Vel-positive blood, making the system clinically significant. In addition to the classical Vel-positive and Vel-negative phenotypes, a weak Vel phenotype has also been described and is associated with reduced and variable expression of the antigen on the red blood cell surface. The physiological role of the antigen remains poorly understood, although it may have a minor influence on hematological parameters.

Genetically, the Vel antigen is inherited as a dominant trait and depends on the expression of *SMIM1*, a gene located on chromosome 1p36. Phenotypic identification can be performed by agglutination testing with anti-Vel antibodies, but serologic diagnosis may be limited by variability in antigen expression. For this reason, molecular methods, especially *SMIM1* genotyping and detection of the characteristic 17 base pair deletion, provide a more reliable approach for identifying the Vel-negative phenotype.

Keywords: Vel blood group system, red cell antigen, *SMIM1* gene, alloimmunization,

THE COLTON BLOOD GROUP: FROM MOLECULAR BASIS TO TRANSFUSION PRACTICE

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The Colton blood group system (CO) is the 15th blood group system recognized by the International Society of Blood Transfusion (ISBT), having been discovered in 1967. This system is defined by antigens (Ag) located on aquaporin-1, a multipass membrane glycoprotein which is found in the membrane of red blood cells and encoded by the *AQP1* gene, present in chromosome 7p14.

There are four antigens, Coa , Cob, Co3 and Co4 whose expression determines the different phenotypes, being Co (a^+,b^-) the most common and Co (a^-, b^-), the null phenotype, rare.

Although less significant than the ABO and Rh systems, the CO system is clinically important in specific contexts. Antibodies directed against antigens in this system are immune and irregular and may be associated with alloimmunization, hemolytic transfusion reactions and, more rarely, with Hemolytic Disease of the Fetus and Newborn because these antibodies are typically IgG and they can cross the placenta.

In addition, the rare Co(a^-, b^-) phenotype, characterized by the absence of *AQP1*, can lead to the development of anti-Co3 antibodies, significantly complicating transfusion management due to the scarcity of compatible donors.

The IPST plays a key role in transfusion safety, including the phenotyping of less common blood group systems in specific situations, such as in patients who have received multiple transfusions. The identification of anti-Colton antibodies, such as anti-Co^a or anti-Co^b, can pose an additional challenge in selecting compatible blood units and preventing transfusion complications.

Keywords: Colton blood group, aquaporin-1, antigens, antibodies, phenotype, transfusion, IgG

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DRUG RESISTANCE: CELLULAR AND MOLECULAR MECHANISMS

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Drug resistance occurs when a microorganism is exposed to the drug designed to kill it, or at least inhibit them but it survives. This resistance is due to cellular mechanisms and molecular mechanisms, this can occur both in cancer and infectious diseases.

Some cellular mechanisms that can result in drug resistance are the concentration of the drug on a cellular level and how their transport happens. When the cell membrane undergoes alterations it can reduce drug permeability and modify the drug influx and efflux. At a cellular level cancer cells can escape apoptosis, they can also alter cellular checkpoints so the drug has no effect. The tumor heterogeneity contributes significantly to the drug resistance.

At a molecular level mechanisms include mutations that modify the drug target which inhibits or reduces the drug effect, some microorganisms can chemically modify the drug, typically by phosphorylation, they can be cleaved, methylated, or degraded by cellular enzymes. In chemotherapy the DNA in tumor cells is damaged and some unregulated DNA repair pathways are activated which creates drug resistance.

There are intrinsic and acquired multidrug resistance, some of the intrinsic may result from pre-existing, such as inherited genetic alterations and unresponsive subpopulations, which reduces the drug effect. Some acquired resistance mechanisms are new mutations.

A few of the strategies to tackle resistance are alterations in the drug targets and activation of compensatory pathways, improving DNA repair mechanisms and innovations in drug delivery.

Keywords: Drug resistance, microorganism, drug transport, mutation

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CYSTIC FIBROSIS: MULTISYSTEM HISTOLOGICAL CHANGES

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Cystic fibrosis is an autosomal recessive disease caused by mutations of the gene encoding the cystic fibrosis transmembrane conductance regulator (CFTR), which is located on chromosome 7. This protein has transmembrane transport functions and belongs to the ABC family (ATP-binding cassette). This monogenic disease is the most common life-shortening pathology that afflicts people of Northern European descent. There are around 80 000 patients diagnosed with cystic fibrosis all over the world and about 1000 cases are newly diagnosed every year. In the pathophysiologic mechanisms, the unfolded mutated protein is retained in the endoplasmic reticulum (ER), provoking stress and modifying the cell membrane and the transport of chloride ions, inducing to an accumulation of the ions and lacking of hydration of extracellular mucus and secretions. Cystic fibrosis is a disease that affects a large number of organs, like the lungs, pancreas, liver, intestine and the reproductive system.

Furthermore, the most frequent symptoms are persistent coughs, lung inflammations, thick viscous secretions, male infertility and some nutrition/growth disorders. The diagnosis is established based on the presence of one or more clinical features suggestive of the disease, family history, and/or a positive result on neonatal screening, combined with laboratory confirmation of *CFTR* gene dysfunction. Treatments for cystic fibrosis include CFTR modulators, respiratory physical therapy, inhaled antibiotics, and mucolytics.

Supportive care focuses on pancreatic enzymes, a high-calorie diet, and vitamins. Emerging therapies such as gene editing and phages target rare mutations and bacterial multidrug resistance; in more advanced cases, lung transplantation is considered.

Keywords: Cystic Fibrosis, *CFTR*, protein, mutation, transport

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PHARMACODYNAMICS OF ANTI-INFLAMMATORY DRUGS AND TISSUE IMPACT

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Anti-inflammatory drugs are highly used for treating patients whose conditions are autoimmune and inflammatory linked. These tend to act on different pharmacodynamic mechanisms aiming to adjust the inflammatory response. Among the main groups, it is noticeable the non-steroidal anti-inflammatory drugs (NSAIDs) and the corticosteroids, which have an impact on diverse pathways. In particular, the NSAIDs are the most commonly used drugs today and work mainly in the inhibition of the cyclooxygenase enzymes, which are present in two distinct forms, COX-1 and COX-2. As a consequence of this process a reduced number of prostaglandins involved in the inflammation is expected.

In this way, the corticosteroids will be willing to modulate gene expression through interactions with intracellular receptors, suppressing the production of pro-inflammatory cytokines and different types of mediators. As a result, these mechanisms reduce the inflammatory response despite the interference with physiological and crucial processes.

Undoubtedly, the tissue impact will specifically depend on the type, dose, and duration of the treatment. The extended use of NSAIDs is also known to be associated with adverse effects such as gastrointestinal and cardiovascular complications. Meanwhile, corticosteroids can bring multiple collateral disadvantages which can range from aesthetic conditions to immunologic effects. In a nutshell, even though both can be effective in inflammatory control, these drugs show a risk that requires appropriate follow-up.

It is fundamental to understand the pharmacodynamic mechanisms and their effects at the tissue level, it is vital to properly tailor the clinical use of these drugs, increasing the efficiency of the treatment and with the purpose of reducing the adverse effects, giving the individual a safer and more specific approach.

Keywords: anti-inflammatory drugs, NSAIDs, corticosteroids, pharmacodynamics, tissue impact

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CARDIAC AMYLOIDOSIS: DEPOSITS AND FUNCTIONAL IMPACT

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Cardiac amyloidosis (CA) is a disease in which misfolded proteins accumulate within the myocardium. The two main types are light chain amyloidosis (AL), caused by abnormal plasma cells and is usually aggressive, and transthyretin amyloidosis (ATTR), caused by misfolded transthyretin protein. ATTR can be subdivided in two forms, the wild-type ATTR and the variant/hereditary ATTR.

It is often mistaken for hypertrophic cardiomyopathy or heart failure with preserved ejection fraction, leading to frequent underdiagnosis. Correct identification of AL versus ATTR is crucial, as prognosis and treatment differ.

CA results from extracellular deposition of insoluble fibrils formed by proteins that misfold into a beta-pleated sheet structure. Deposits are mainly interstitial, involving the myocardium between cardiomyocytes, and may extend to the atria, valves, and conduction system, causing ventricular wall thickening and a restrictive cardiomyopathy phenotype. Amyloid deposition increases myocardial stiffness and impairs ventricular relaxation, resulting in diastolic dysfunction and, in advanced stages, systolic impairment. Atrial and conduction system involvement promotes arrhythmias and increases the risk of sudden cardiac death, while in AL, direct cardiotoxic effects further exacerbate myocardial dysfunction.

The diagnosis relies on Congo Red stained biopsy or non-invasive methods (MRI, for example). Mass spectrometry typing is critical to distinguish AL (chemotherapy emergency) from ATTR (disease-specific therapy), being essential for prognosis and genetic counseling.

CA severity reflects the extent and distribution of amyloid deposits. Ventricular infiltration leads to stiffness and restrictive physiology, while atrial involvement triggers dilation and arrhythmias. Biomarkers, imaging, and semi-quantitative pathological typing guide prognosis, therapy, and subtype differentiation.

Keywords: Cardiac amyloidosis, light-chain amyloidosis, transthyretin amyloidosis, amyloid fibrils, diastolic dysfunction

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NEURODEGENERATION AND EMERGING THERAPIES: HISTOPATHOLOGIC IMPACT

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Neurodegenerative diseases constitute a heterogeneous group of disorders characterized by an irreversible process that leads to the progressive loss of neuronal structure and function, resulting in several disorders such as Alzheimer's disease, Parkinson's disease, Amyotrophic Lateral Sclerosis and Huntington's disease. These processes result from the interaction of multiple cellular and molecular mechanisms including oxidative stress, mitochondrial dysfunction, neuroinflammation, excitotoxicity and disruptions in proteasis, ultimately leading to the accumulation of abnormal proteins and neuronal death.

From a histopathological standpoint, these diseases exhibit distinct features such as, the accumulation of abnormal proteins, for example, deposition of beta-amyloid and TAU protein in Alzheimer's disease, the presence of Lewy bodies in Parkinson's disease, TDP-43 aggregation in Amyotrophic Lateral Sclerosis, which contributes to cellular dysfunction and neuronal death, and mutant huntingtin inclusions in Huntington's disease. Despite these differences, they share common pathogenic mechanisms, particularly protein aggregation and neuroinflammation.

Advances in neurogenerations research have recently incorporated concepts such as autophagy dysfunction, the gut-brain axis and cellular senescence, leading to the development of emerging therapies. These include precision immunotherapy, metabolic reprogramming, nanotechnology to cross the blood-brain barrier, stem cell therapies and personalized pharmacogenic approaches.

In parallel, diagnostic advances, through imaging techniques and the analysis of biomarkers in the cerebrospinal fluid and plasma have enabled substantially earlier and more precise diagnoses. The integration of histopathological knowledge with therapeutic innovations represents a promising approach to improving the prognosis in neurodegenerative diseases.

Keywords: Neurodegeneration, emerging therapies, histopathologic alterations, oxidative stress, biomarkers

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LYSOSOMAL DISEASES: TYPICAL HISTOLOGICAL PATTERNS

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Lysosomal diseases are a heterogeneous group of hereditary metabolic pathologies caused by enzymatic deficiencies, which prevent the normal degradation of macromolecules and lead to the progressive accumulation of non-degraded substrates. This process leads to lysosomal stress that activates apoptotic pathways and generates inflammation, impairing cellular metabolism and leading to the progressive death of affected cells.

The most common histological pattern, shows enlarged cells with vacuolated cytoplasm, reflecting lysosomal expansion. The vacuoles may appear either clear or finely granular on hematoxylin and eosin staining, depending on the material stored. In diseases with lipid accumulation, cells with foamy cytoplasm are observed, especially in macrophages of the liver, spleen, and bone marrow.

In the central nervous system, increased neuron volume due to cytoplasmic storage material is common, associated with progressive neuronal loss, reactive gliosis and the presence of inclusion bodies. The skeletal muscle may show changes compatible with vacuolar myopathy, while connective tissue may show expansion of the extracellular matrix due to glycosaminoglycan deposition.

Electron microscopy may reveal characteristic inclusions, such as concentric lamellar bodies or organized membrane structures. The identification of these histological patterns, even if they are rarely definitive, together with clinical data and biochemical or genetic tests, is essential to guide the diagnosis as they provide important clues to recognize the underlying metabolic effect for the selection of appropriate confirmatory tests.

Keywords: Lysosomal diseases, histological patterns, enzymatic deficiencies, lysosome,

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GENOTYPE-PHENOTYPE RELATIONSHIP IN HEREDITARY DISEASES

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Hereditary diseases are genetic alterations transmitted from parents to children that can affect the normal functioning of the organism. These alterations may be present in a single gene or in entire chromosomes. Depending on the type of mutation, different clinical manifestations may arise, ranging from mild symptoms to more serious illnesses. The study of these conditions allows a better understanding of the relationship between genotype and phenotype. The relationship between genotype and phenotype is a fundamental concept for understanding hereditary diseases. A genotype refers to an individual's genetic constitution, including the specific DNA sequence and the variants present in the genes. Genotype determines an individual's phenotype. A phenotype refers to the observable characteristic of an individual, such as height, eye color, and blood type, resulting from the expression of the genotype. A genetic mutation can cause specific symptoms including alterations in the blood, organs, or metabolism. However, individuals with the same genotype may present different phenotypes due to epigenetic modifications, the influence of other genes or even environmental factors. Therefore, studying the relationship between genotype and phenotype is essential to better understand the severity and progression of different hereditary diseases, such as the respective diagnosis, prognosis and therapeutic strategies.

Keywords: genotype, phenotype, hereditary diseases, genetic mutation

Discipline: Hearing Rehabilitation Technologies

Professor: Carla Matos Silva; Ana Filipa Carvalho; Cristina Nazaré

Degree: Audiology

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AUDITORY REHABILITATION OF CHILDREN WITH UNILATERAL SENSORIONEURAL HEARING LOSS

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Introduction: In the past, sensorineural hearing loss of severe to profound degree, unilateral, in children was not rehabilitated. However, scientific evidence began to show that acoustic stimulation of both pathways is fundamental for cortical organization, particularly for sound localization and speech perception in noise. Rehabilitation of this type and degree of hearing loss was done with conventional hearing aids, with Contralateral Routing of Signal (CROS), or with osseointegrated implants. After approval by the Food and Drug Administration (FDA), the Cochlear Implant (CI) also became a viable solution. Objective: Based on a literature review, to study auditory rehabilitation in children with severe to profound unilateral sensorineural hearing loss. Methodology: Bibliographic research conducted in the Web of Science, B-on, Pubmed, and Scopus databases, using the keywords Unilateral hearing loss; child; and hearing rehabilitation. Articles from the last 5 years were considered, original, totaling 18 articles, with 3 excluded for being systematic reviews and 4 for conductive hearing loss, with the remaining 11 considered in the present analysis. Results: Among the previously mentioned solutions, the cochlear implant improves speech perception in noise, sound localization, and language development, bringing these children closer to their normal-hearing peers. This occurs because the cochlear implant provides direct auditory stimulation to the ear with hearing loss, promoting the activation of auditory pathways, which reduces the time of auditory deprivation and its consequences on the child's neurodevelopment. Conclusion: In these cases, early rehabilitation of unilateral hearing loss in children is essential, with the CI being considered the best solution.

Keywords: Unilateral hearing loss; child; Auditory rehabilitation

Discipline: Hearing Rehabilitation Technologies

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Degree: Audiology

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AUDITORY REHABILITATION IN MENIERE'S DISEASE: CHALLENGES AND TECHNOLOGICAL INNOVATION

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Introduction: Meniere's Disease (MD) is a complex inner ear pathology where endolymphatic hydrops causes fluctuating hearing loss and vestibular instability. Objective: Based on a systematic review, this study analyzes clinical challenges of auditory rehabilitation in MD and the impact of emerging technological solutions. Methodology: A bibliographic search was conducted in PubMed and Web of Science using keywords: "Meniere's Disease", "Auditory Rehabilitation", "Cochlear Implant", and "Machine Learning". Original articles and guidelines from 2008 to 2023 were analyzed. From 52 identified sources, 6 primary articles were selected for qualitative synthesis. Results: Conventional hearing aid fitting is hindered by unpredictable hearing thresholds. However, evidence shows that allowing patients to manually self-adjust device gain or switch between pre-set programs during fluctuations leads to 70% satisfaction rates. Without these flexible options, static programming often becomes inadequate, causing discomfort or insufficient amplification. In advanced stages, cochlear implants significantly improve speech discrimination. Future rehabilitation focuses on Machine Learning for automated real-time optimization and vestibulocochlear implants for simultaneous sensory stabilization. Conclusion: These innovations aim to stabilize sensory input, reducing cognitive load and anxiety. Transitioning to dynamic, patient-centered technology promotes superior social and professional reintegration for individuals with MD.

Keywords: Meniere's Disease; Auditory Rehabilitation; Cochlear Implant; Machine Learning; Vestibulocochlear Implant.

Discipline: Hearing Rehabilitation Technologies

Professor: Carla Matos Silva; Ana Filipa Carvalho; Cristina Nazaré

Degree: Audiology

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ASSISTIVE TECHNOLOGIES FOR PEOPLE WITH HEARING LOSS

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Introduction: The inclusion of people with hearing loss requires overcoming communication barriers to ensure the exercise of citizenship. Assistive and digital technologies emerge as fundamental mediators, functioning as accessibility tools that promote autonomy. The effectiveness of these resources depends on their correct implementation within society, ensuring full and equitable participation in all social contexts.

Objective: Based on a literature review, this study aims to analyse the fundamental role of Assistive Technologies (AT) in promoting autonomy and the inclusion of people with hearing loss in social and educational contexts.

Methodology: A bibliographic search was conducted in the PubMed database using the keywords: support, inclusion, hearing loss, and assistive technologies. The final selection comprised two articles published in 2025, which served as the basis for the present analysis.

Results: Studies highlight that assistive technologies, such as Hand Talk, V-Libras, transcription software, and prosthetics, are fundamental mediators in the inclusion of people with hearing loss. These resources and digital tools eliminate communication barriers, enhancing autonomy and universal accessibility. The effective use of these adapted devices guarantees the full and equitable participation of deaf people in various social contexts, ensuring the exercise of citizenship in everyday scenarios.

Conclusion: The introduction of these tools aims to reduce communication barriers, allowing individuals with hearing impairment to have equal access to information and language development, although they require a balance between technological support and human awareness.

Keywords: Hearing Impairment; Inclusion; Assistive Technologies; Deafness; Hearing Loss

Discipline: Hearing Rehabilitation Technologies

Professor: Carla Matos Silva; Ana Filipa Carvalho; Cristina Nazaré

Degree: Audiology

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AUDITORY REHABILITATION IN CHILDREN WITH COCHLEAR IMPLANTS: UNILATERAL *VS.* BILATERAL

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Introduction: Cochlear implantation is the main intervention in auditory rehabilitation for children with severe to profound bilateral sensorineural hearing loss. The comparison of the benefits of bilateral versus unilateral implantation justifies the increase in the number of bilateral cochlear implants, not only at the auditory level, but also in terms of linguistic, cognitive, and functional dimensions. Objective: To compare the results of unilateral and bilateral cochlear implantation in pediatric age, analyzing the impact on speech perception, language development, and binaural integration. Methodology: Narrative literature review with searches conducted in the PubMed, Scopus, and Web of Science databases. Thirteen articles were selected, excluding one due to an associated pathology. Studies published between 2012 and 2025 that compared the type of cochlear implantation in children were included. Variables such as implantation age, interval between implants, prior use of hearing aids, and family factors were considered. Results: The results indicate that simultaneous and sequential bilateral implantation provide benefits in speech perception in noise, sound localization, and linguistic development. Simultaneous implantation offers initial advantages in binaural integration. Sequential implantation can achieve similar results when performed early. Prolonged intervals between surgeries are associated with poorer performance of the second ear; a short interval, less than one year, is recommended. Conclusion: Bilateral cochlear implantation offers benefits, especially in complex acoustic environments. The clinical decision should be individualized, considering clinical, temporal, and family factors.

Keywords: Unilateral cochlear implant; Bilateral cochlear implant; Children; Speech perception in noise; Language development.

Discipline: Hearing Rehabilitation Technologies

Professor: Carla Matos Silva; Ana Filipa Carvalho; Cristina Nazaré

Degree: Audiology

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QUALITY OF LIFE IN CHILDREN WITH HEARING LOSS: COMPARISON BETWEEN COCHLEAR IMPLANT USERS AND HEARING AID USERS.

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Introduction: Hearing loss in childhood can significantly affect language development, communication, and social interactions, influencing children's quality of life. Auditory rehabilitation improves access to sound stimuli and supports cognitive, social, and emotional development. Objective: To compare the quality of life of children with hearing loss who use cochlear implants and those who use hearing aids, based on the available scientific evidence. Methodology: A bibliographic search was conducted in the Web of Science and PubMed databases using the keywords hearing loss, cochlear implant, hearing aid, and quality of life. Articles from the last 5 years were considered, totaling 19 studies. Of these, 4 were excluded for being older, 4 academic works, and 3 literature reviews, leaving 8 articles included in the present analysis. Results: The analyzed studies indicate that children with cochlear implants tend to show better outcomes in several dimensions of quality of life compared to children rehabilitated with hearing aids, particularly in communication, social participation, and school integration. Some studies report improvements in cognitive development associated with more effective access to auditory stimuli. However, age at diagnosis, timing of intervention, and degree of hearing loss may influence the results. Conclusion: Both hearing aids and cochlear implants contribute to improving the quality of life of children with hearing loss. However, the literature suggests that cochlear implants may provide additional benefits, especially in communication and social integration. Early intervention and multidisciplinary follow-up are essential to optimize auditory rehabilitation outcomes.

Keywords: Childhood Hearing Loss; Cochlear Implant; Hearing Aids; Quality of Life; Auditory Rehabilitation

LEVELS OF KNOWLEDGE AND BEST PRACTICE IN THE USE OF SEASIDE BEACHES

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The quality of bathing water is a key factor in protecting public health and preserving the environment, especially in countries with a strong tradition of beachgoing, such as Portugal. The aim of this study was to assess the Portuguese population's level of knowledge and best practices regarding the use of seashore beaches.

An observational, cross-sectional, quantitative study was conducted, based on an online questionnaire administered to 32 participants residing in Portugal. The instrument collected data on sociodemographic characteristics, knowledge of bathing water quality, risk perception, and behavioral practices.

The results show reasonable levels of general knowledge, but with gaps in the understanding of specific concepts, such as the meaning of bathing water classifications (only 50% of respondents know the meaning of water classified as "Excellent"). A high perception of risk was observed, but low adoption of preventive behaviors, particularly regarding checking information before going to the beach (only 1.3% of respondents confirm the water classification before going to the beach). Individual environmental practices were mostly positive, although there is a negative perception regarding collective behavior.

It can be concluded that, despite the existence of knowledge and risk perception, discrepancies between knowledge and behavior persist, underscoring the need for more effective environmental education and risk communication strategies.

Keywords: bathing water, public health, environmental literacy, environmental behavior, coastal beaches

CLIMATE CHANGE AND BATHING WATER QUALITY

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Climate change poses a growing threat to the quality of bathing waters, impacting leisure, tourism, and public health. The intensification of phenomena such as rising water temperatures and extreme rainfall accelerates the degradation of these ecosystems, promoting the proliferation of pathogenic microorganisms and the runoff of terrestrial pollutants. European legislation, such as Directive 2006/7/EC, establishes strict controls, but climate unpredictability challenges the effectiveness of monitoring and requires continuous reassessment of risks. This study aimed to analyze the impacts of climate change on bathing water quality and assess the public's knowledge level regarding these risks, with the goal of developing effective communication strategies.

The methodology was based on a systematic review of scientific literature, focusing on articles and technical reports from the last two decades. The results revealed a direct and significant correlation between climatic variables and the degradation of bathing water quality, with rising temperatures favoring pathogen proliferation and extreme precipitation contributing to the transport of fecal indicators. It is concluded that climate change exerts multifaceted pressure on bathing water quality, requiring the adaptation of monitoring and management strategies. The implementation of awareness campaigns that translate scientific data into accessible messages, the integration of real-time warnings based on predictive models, and a greater focus on environmental education are recommended to ensure the sustainability of bathing tourism and the protection of public health.

Keywords: Climate Change, Water Quality, Bathing Waters, Public Health, Microbiological Pollution.

LEVEL OF KNOWLEDGE AND BEST PRACTICES REGARDING *LEGIONELLA*

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Legionella, particularly *Legionella pneumophila*, is a bacterium found in natural and artificial aquatic environments and can cause Legionnaires' disease, a respiratory infection transmitted through aerosol inhalation. This study aimed to assess the level of knowledge and the implementation of *Legionella* prevention and control measures in water systems, as well as to identify gaps associated with professional practice. An observational, descriptive, and cross-sectional study was conducted, based on a literature review of two international studies. The results showed that, although there is a moderate level of theoretical knowledge about the disease, significant gaps persist in the identification of risk factors and in the implementation of practical measures, particularly regarding diagnosis and the use of laboratory tests. A discrepancy was also observed between theoretical knowledge and its application in clinical practice. The findings highlight the need to strengthen professional training, improve the implementation of protocols, and ensure compliance with legal standards in order to minimize the risk of infection associated with water systems.

Keywords: *Legionella*, public health, prevention and control, professional knowledge, risk assessment

WATER QUALITY IN PUBLIC AND PRIVATE SWIMMING POOLS: STANDARDS AND BEST PRACTICES

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Water quality in public and private swimming pools is a crucial factor for protecting users health and preventing diseases associated with pool use. Pool water can be easily contaminated by microorganisms and substances introduced by users, making the implementation of appropriate treatment and control measures essential. This study aimed to understand the importance of water quality in swimming pools, as well as to identify the main control parameters, applicable regulations, and best maintenance practices. A bibliographic and documentary research methodology was employed, analyzing scientific articles, legislation, and technical standards related to swimming pool water quality. The results highlight the importance of regular monitoring of physicochemical parameters, such as pH, free residual chlorine, and turbidity, as well as microbiological parameters related to potentially pathogenic microorganisms. It was also found that public pools are subject to stricter regulatory requirements and more demanding health surveillance programs compared to private pools. The study concludes that the application of good maintenance practices and compliance with technical standards are essential to ensure adequate sanitary safety conditions and promote the safe use of swimming pools.

Keywords: water quality, swimming pools, public health, disinfection, health surveillance

LEVEL OF KNOWLEDGE AND BEST PRACTICES IN THE USE OF SWIMMING POOLS (INDOOR OR OUTDOOR)

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The use of indoor and outdoor swimming pools is a widespread activity associated with leisure, physical activity, and health promotion. However, the quality of swimming pool water plays a crucial role in preventing public health risks, including microbiological infections, skin and eye irritation, and respiratory problems related to exposure to disinfection by-products. Proper pool maintenance requires the control of physicochemical and microbiological parameters, as well as the adoption of appropriate behaviours by users.

This study aims to assess the level of knowledge and practices of Portuguese swimming pool users regarding safe use and good practices, with a focus on promoting water quality and preventing health risks. A quantitative and descriptive study was conducted through the application of an online questionnaire targeting individuals aged 18 years or older who use indoor or outdoor swimming pools in Portugal. The questionnaire collected information on participants' knowledge of hygiene and safety guidelines, as well as their behaviours before, during, and after using swimming pools.

The findings are expected to contribute to a better understanding of users' literacy in this context and to identify potential gaps in knowledge or practices, supporting the development of health education strategies and the promotion of safe behaviours in aquatic environments.

Keywords: swimming pools, water quality, public health, user behaviour, hygiene practices

LEGIONELLA CONTAMINATION IN WATER SYSTEMS: RISKS IN HOTELS, HOSPITALS AND SWIMMING POOLS - LEVEL OF KNOWLEDGE AND BEST PRACTICES

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Legionella spp. is an aquatic microorganism of major public health relevance, associated with Legionnaires' disease, a severe form of pneumonia transmitted through the inhalation of contaminated aerosols. Its colonization commonly occurs in artificial water systems, such as building water networks, swimming pools, and aerosol-generating devices, particularly under favorable environmental conditions, posing increased risks in settings such as hotels, hospitals, and recreational facilities.

This study aimed to analyze the risks associated with the presence of *Legionella* in such systems and to assess the population's level of knowledge and practices regarding this issue. A literature review on risk factors, proliferation mechanisms, and control strategies was conducted, complemented by a questionnaire applied to the general population.

The sample included 91 participants with diverse sociodemographic characteristics. Results revealed heterogeneous levels of knowledge, with 61.5% correctly identifying inhalation of contaminated aerosols as the main transmission route. However, misconceptions were evident, as 37.4% associated infection with water ingestion and 6.6% with skin contact, while 13.2% reported not knowing the transmission route.

These findings highlight significant gaps in public awareness regarding *Legionella*. Despite growing attention to this issue, there is a clear need to strengthen health education and awareness initiatives, alongside implementing effective monitoring and water quality control strategies in high-risk environments

Keywords: *Legionella* spp., water quality, public health, water systems, aerosols

Discipline: Water Quality Management II

Professor: Cristina Santos

Degree: Environmental Health

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LEGISLATION AND CONTROL MEASURES FOR *LEGIONELLA* IN PORTUGAL

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This study addresses the legislation and control measures for *Legionella* in Portugal, focusing on the transposition of Directive (EU) 2020/2184 into national law through Decree-Law no. 69/2023. The research analyzes the importance of risk-based approaches and Water Safety Plans (WSPs) in preventing Legionnaires' Disease. Through a questionnaire administered to professionals in the sector, the level of knowledge about legislation, the implementation of prevention plans, monitoring frequency, and the main difficulties encountered were assessed. The results indicate a high awareness of the importance of guidelines from the Directorate-General of Health and surveillance mechanisms, but reveal gaps in in-depth knowledge of legislation and specific training for professionals. Variability in the application of control measures and the perception of a lack of resources and knowledge are identified as significant barriers. It is concluded that the effectiveness of *Legionella* prevention in Portugal requires strengthening continuous training, more transparent oversight, and practical support for facility managers, promoting a proactive prevention culture to safeguard public health.

Keywords: *Legionella*, Legislation, Control, Water Quality, Public Health

Discipline: Nutrition Policy

Professor: Elsa Feliciano e João Lima

Degree: Dietetics and Nutrition

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ACTIVE SCHOOL, HEALTHY ENVIRONMENT

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Introduction: The low consumption of fruits and vegetables among children and young people is a public health problem. This situation is worsened by the predominant availability of ultra-processed foods in the school environment, which leads to an increased risk of obesity and chronic diseases. To reverse this trend, it is essential to combine educational strategies with improvements to the food environment. The prevalence of inequity in fruit and vegetable consumption is 70 to 80% among children and young people.

Objectives: To develop and implement the nutritional policy “Active School, Healthy Environment,” which contributes to increasing the consumption of fruits and vegetables among children and young people.

Methodologies: Sites such as PNPAS, DGS, COSI and IAN-AF were analysed.

Results: This policy will be based on three pillars: requalification of the surrounding food environment, promotion of literacy within the school community, and food education within the Citizenship subject. Its implementation relies on the support and partnership of local producers, municipalities, commercial and educational establishments, and health centers. To this end, measures have been defined such as offering healthy options in establishments involved with schools, valuing local horticultural products and reducing food waste, creating incentives and certification for participating establishments, and promoting food literacy through the development of the theme of healthy eating. This policy is expected to last between 18 and 24 months.

Conclusion: This nutritional policy aims to increase the consumption of horticultural products and food literacy, contributing to the reduction of obesity and chronic diseases.

Keywords: Healthy eating, School environment, Fruit and vegetable consumption, Food literacy, Nutritional policy

THE UP-SCORE: A METRIC FOR ASSESSING THE DEGREE OF PROCESSING FOOD

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Introduction: High consumption of ultra-processed foods is associated with a significant increase in the risk of chronic noncommunicable diseases such as obesity, type 2 diabetes, and cardiovascular disease. Current labeling, which focuses solely on nutritional composition, does not allow consumers to quickly identify the degree of processing, a determining factor in metabolic risk. Evidence shows that simplified visual schemes are significantly easier for consumers to interpret compared to traditional nutritional tables, requiring innovative food policy to protect public health.

Objective: Develop a public policy proposal for the implementation of UP-SCORE.

Methodology: Tools such as Nutri-score and the NOVA classification were analyzed, as well as the PNPAS and DGS websites.

Results: This policy is based on three strategic axes: a regulatory framework, public awareness, and food industry awareness. Building on these pillars, a conceptual model for mandatory front-of-pack labeling was developed, integrating a NOVA-based UP-Score to identify the degree of food processing.

This model aims to facilitate the interpretation of overall food quality, promote more informed dietary choices, and encourage product reformulation by the food industry.

The policy's implementation envisions a phased 2.5-year timeline, supported by a partnership plan involving the Ministries of Economy, Health, and Industry, the DGAV, and the large-scale retail sector, to ensure its effective execution.

Conclusion: The UP-Score proposes a necessary paradigm shift in food policy. Future research must assess its effectiveness in shifting consumption patterns and reducing metabolic risks over the 2.5-year rollout.

Keywords: Ultra-processed foods; Food labeling; Food policy; Degree of processing.

SNS + SAÚDE

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Introduction: The rise in chronic noncommunicable diseases calls for innovative solutions based on the digital transformation of healthcare. Since healthy eating and physical activity are two pillars of health promotion and, consequently, of preventing the rise in these diseases, these were the key areas addressed in this initiative. The development of a tab within the SNS app serves as a strategic tool to centralize public health resources and combat misinformation.

Objective: To develop and implement the "SNS+Saúde" policy to promote healthier lifestyles through nutritional monitoring, food and physical literacy, and affordable meal planning.

Methodology: The proposal was based on an analysis of the PNPAS and PNPAF guidelines, as well as epidemiological data from the Directorate-General for Health and the WHO.

Results: The three-year policy, set to begin in 2027, is structured around four pillars: Nutritional Surveillance, Health Literacy Promotion, Physical Activity Promotion, and Healthy and Sustainable Eating Promotion. In the first year, the first and second pillars will be implemented. In the second year, the remaining pillars will be implemented. The project's feasibility relies on partnerships between the Ministry of Health (SNS, ULS Coimbra, PNPAS, and PNPAF), the Ministry of Education (educational institutions: ESTeSC and FCDEF), and support from the Ministry of Administrative Modernization.

Conclusion: This policy is expected to increase citizens' autonomy in managing their health, reducing the burden on primary care by fostering a more informed, active, and healthy population.

Keywords: Nutrition Policy; Food Literacy; Digital Health; National Health Service; Health Promotion.

DESCODIFICA +

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Introduction: Obesity is a significant public health problem in Portugal, associated with high consumption of ultra-processed foods rich in sugar, salt, and fat, and low levels of food literacy. This context highlights the need to develop public policies that promote healthier food environments and encourage more balanced food choices by the population.

Objective: To develop and implement a national food policy that promotes healthier food environments, reduces the consumption of foods high in sugar, salt, and fat, and contributes to the prevention of obesity by empowering the population to make more informed food choices.

Methodology: The proposal was developed based on the analysis of national and international documents and recommendations in the area of public health and nutrition, including PNPAS guidelines, DGS reports, and recommendations from European institutions.

Results: The proposed policy is structured around three main axes: a regulatory axis, work with the food industry, and public awareness. Only products classified as "high in" should have a visible warning on the packaging, allowing for easy identification of foods with a greater negative impact on health. The policy is expected to last five years and may involve collaboration between public entities, the food industry, and research institutions.

Conclusion: This policy is expected to contribute to improving the population's food literacy, facilitating the identification of less healthy foods, and promoting more conscious food choices, thus contributing to a reduction in the prevalence of obesity in Portugal.

Keywords: Obesity, Policy, Nutrition, Food literacy

Discipline: Nutrition Policy

Professor: Elsa Feliciano e João Lima

Degree: Dietetics and Nutrition

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ZERO WASTE, ZERO HUNGER

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Introduction: Food waste represents a significant challenge in today's food systems. In Portugal, this phenomenon has been increasing in recent years, rising from 1.8 million tons in 2020 to 1.9 million tons in 2023. At the same time, food insecurity persists, affecting around 19.3% of Portuguese families, highlighting the need for strategies that reduce waste and promote equitable access to food.

Objective: Develop and implement a National Nutritional Policy to Combat Food Waste and Food Insecurity.

Methodology: For the development of this policy, our research was based on PNPAS, IAN-AF 2015-2016, and the programme (EIPAS).

Results: The national nutrition policy to be implemented from 2026 to 2030. Its main pillars are reducing food waste, reducing food insecurity, and promoting food literacy in at-risk families.

To achieve the objectives of the policy to be instituted, agreements and protocols will be established with municipal markets, grocery stores, bakeries, fruit shops in each municipality, and local farmers with a view to recovering and redistributing food surpluses that are still safe for consumption. This food will be directed to families in situations of food insecurity, simultaneously contributing to the reduction of waste and improved access to food. The identification of beneficiary families will be the responsibility of the municipalities, in coordination with local social services.

Conclusion: With the implementation of this nutritional policy based on the defined strategies, a reduction in food waste from small businesses is expected, thereby reducing food insecurity among families identified by each municipality.

Keywords: Food Waste, Food Insecurity, Nutrition Policy and Portugal.

Discipline: Nutrition Policy

Professor: Elsa Feliciano e João Lima

Degree: Dietetics and Nutrition

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DEVELOPMENT OF A NUTRITIONAL POLICY TO PROMOTE HEALTHY EATING IN WORKPLACES

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Introduction: Workplaces are spaces where nutritional interventions have become increasingly important due to many factors. Because it's the place where most adults spend their day, nutrition plays a fundamental role promoting healthy eating, both inside and outside of work, passing these habits onto each worker's family.

Objective: Develop a nutritional policy to promote healthy eating in workplaces.

Methodology: Research was conducted on the following official websites: Programa Nacional para Promoção da Alimentação Saudável (PNPAS), Estratégia Integrada para a Promoção da Alimentação Saudável (EIPAS) e Inquérito Alimentar Nacional e de Atividade Física (IAN-AF) to base the pillars of the nutrition policy developed.

Results: This policy would be implemented in January 2027 with the duration of 2 years. It was divided into three pillars: “Improvement of the Food Offer”, “Food Literacy” and “Nutritional Follow-up”. The first pillar is to reformulate the food offer in workplaces (canteen, bar, vending machines), promoting a healthy diet. The second pillar is based on increasing the food literacy of all workers, to promote the ability to make conscious and healthy decisions. Finally, the third pillar seeks to ensure that a nutritionist is available in the workplace at the occupational health level in companies, guaranteeing regular nutritional follow up for all workers. The establishment of partnerships with Ordem dos Nutricionistas, catering, food service, and vending machines entities will facilitate the policy implementation.

Conclusion: With the policy implementation, the aim is to improve employees well-being, reduce the rate of chronic diseases and promote a healthy workplace and family environment.

Keywords: workplace, nutritional policies, health, well-being, life quality

SABORES – SYSTEM FOR THE ADAPTATION OF CAFETERIAS AND MEAL SERVICES IN HIGHER EDUCATION

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Introduction: Entering Higher Education represents a period of transition between adolescence and adulthood and is accompanied by new challenges and increased nutritional vulnerability. This often leads young adults to have unbalanced dietary patterns, characterized by higher consumption of simple sugars and lower intake of protein and legumes. This situation, combined with the absence of specific regulations in Higher Education, highlights the need to create national policies that promote healthier food environments within universities.

Objective: Develop and implement a policy to guide eating behavior during the transition of young adults in higher education (SABORES–System for the Adaptation of Cafeterias and Meal Services in Higher Education).

Methodology: The data were analyzed based on national reports and official documents, namely IAN-AF and PNPAS guidelines. Technical and scientific references were also analyzed, including the technical manual developed by APN, SPARE Project, as well as the nutritional and public health DGS guidelines.

Results: The policy is based on the following axes: 1º: Regulation of food availability in university canteens and bars. 2º: Training and capacity building of staff. 3º: Promotion of nutritional literacy among users of higher education food services. This policy will last for approximately three years, for the implementation and evaluation of indicators and outcomes. Partnerships will be established with DGS, the Ministry of Higher Education and ESTeSC.

Conclusion: We hope that the implementation of this policy will contribute to improving the dietary patterns of higher education students by promoting more balanced food choices and healthier food environments within academic institutions.

Keywords: Higher education, healthy eating, young adults, food security

DETERMINANTS OF LOW MEDITERRANEAN DIET ADHERENCE IN PORTUGAL AND THE PORTUGAL

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Introduction: Despite its Mediterranean heritage, Portugal shows declining adherence to the Mediterranean Diet (MD), driven by economic constraints, food insecurity, and sociocultural changes. Evidence indicates that adherence entails higher costs (approximately 21%), disproportionately affecting low-income groups. Food insecurity and lower education levels are associated with poorer adherence and adverse health outcomes, while urbanization accelerates the abandonment of traditional dietary patterns. These findings support the need for structural policy interventions.

Objective: To develop and propose an evidence-based national policy (Portugal Mediterrânico 2030) to improve MD adherence through integrated and equity-oriented strategies.

Methods: Literature review conducted using PubMed, ScienceDirect, Web of Science, and B-On. Included studies comprised systematic reviews, randomized controlled trials, and observational studies addressing determinants of MD adherence and effectiveness of behavioural and structural interventions.

Results: Portugal Mediterrânico 2030 is a 5-year strategy structured across three axes: economic accessibility through the Mediterranean Loyalty System (SNFM) with targeted subsidies; education and behaviour through culinary education and multicomponent interventions increasing adherence; digital and community engagement through the Mediterrâneo+ app and Youth Mediterranean Card (20–40% incentives). Implementation involves partnerships with government, municipalities, schools, and food retailers. Expected outcomes include improved adherence, reduced inequalities, and decreased cardiovascular risk.

Conclusions: It is expected that the implementation of Portugal Mediterrânico 2030 will lead to improved adherence to the Mediterranean Diet, reduction of socioeconomic inequalities in access to healthy foods, and meaningful gains in population health outcomes, supporting its potential as a scalable public health policy model.

Keywords: Mediterranean Diet, Public Policy, Public Health, Nutrition, Cost-Benefit

MEDITERRÂNICO 2030 POLICY

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Introduction: Alcohol consumption is a significant public health problem in Portugal, causing high morbidity and mortality. It is associated with an increased risk of accidents, social problems, chronic non-communicable diseases, and high calorie intake. According to the IAN-AF (2015–2016), alcohol consumption is higher among men and the elderly population.

Objective: Creation and implementation of a national nutrition policy to reduce alcohol consumption.

Methodology: database search such as Analysis of the IAN-AF food survey (2015–2016), EIPAS guidelines from the DGS and PNPAS, Decree-Law No. 330/90 (advertising code) and Decree-Law No. 09/2021 (regime for the sale and consumption of alcoholic beverages).

Results: This policy will be coordinated by the Directorate-General for Health, within the scope of health promotion policies, and implemented in conjunction with the National Health Service, with a pilot period of five years. The labelling axis: mandatory declaration of energy content and alcohol quantity, as well as the inclusion of visual warnings about the risks of consumption. Literacy: increasing public awareness through mandatory prime-time commercials. Integration, in schools, of an educational module on the problems and risks of excessive alcohol consumption, including label reading and awareness campaigns. The marketing and advertising axis: mandatory inclusion of awareness messages in all promotional content and the creation of a national digital information and support platform. This policy aims to contribute to reducing alcohol consumption and improving the nutritional status and health of the population.

Conclusion: This implementation aims to reduce alcohol consumption and, consequently, improve the nutritional and health status of the population.

Keywords: nutritional policy, nutrition, alcohol, national policy, Portugal

Discipline: Human Nutrition

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Degree: Dietetics and Nutrition

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EFFECT OF VITAMIN B12 AND FOLIC ACID SUPPLEMENTATION ON COGNITIVE FUNCTION IN ALZHEIMER'S DISEASE

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Background: Alzheimer's disease is a neurodegenerative disorder characterized by progressive cognitive decline and loss of functional autonomy. It has been associated with elevated homocysteine levels, which may contribute to symptom progression. In this context, nutritional interventions, particularly vitamin B12 and folic acid supplementation, have been proposed as potential therapeutic strategies.

Objective: To evaluate the effects of vitamin B12 and folic acid supplementation on cognitive function, functional capacity, and homocysteine levels in individuals with Alzheimer's disease.

Method: Research was conducted using PubMed with keywords "Vitamin B12" AND "Folic acid" AND "cognitive function". From this search, we've selected a systematic review with meta-analysis on Alzheimer's disease and its relation with vitamin B12 and folic acid.

Results: In this review, five studies showed a significant improvement in Mini-Mental State Examination (MMSE) scores in the supplementation group compared to placebo (SMD = 0.21; 95% CI: 0.01–0.32; p = 0.04) after 6 months. However, no significant differences were found in ADAS-Cog scores (SMD = 0.06; 95% CI: -0.22–0.33; p = 0.68) or functional capacity. A reduction in homocysteine levels was observed.

Conclusion: Vitamin B12 and folic acid supplementation may slightly improve cognitive function (MMSE), possibly linked to reduced homocysteine. However, no consistent effects were seen in other cognitive domains or daily functioning, and further studies are needed.

Keywords: Alzheimer's disease; vitamin B12; folic acid; homocysteine; cognitive function; nutritional supplementation.

IODINE IN THE DIET OF THE PORTUGUESE POPULATION: CURRENT SITUATION AND HEALTH IMPACTS

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Iodine plays an extremely important role in thyroid function; this mineral is essential for the synthesis of thyroid hormones, which are fundamental to the regulation of cellular metabolism and the body's development. Iodine deficiency, whether severe or moderate, can have harmful effects, particularly during pregnancy, and may cause impairments in children's cognitive development. In Portugal, despite its proximity to the sea, an insufficient intake of iodine in the population's diet has been reported. For several years, available data were scarce and outdated. However, more recent studies have drawn attention to this situation, highlighting the possibility that it is a significant public health issue. Currently available data indicate that iodine intake nationwide is around the minimum recommended level. Nevertheless, when compared to data from the 1980s, a significant increase in the intake of this micronutrient is observed. According to the National Institute of Health Dr. Ricardo Jorge (INSA), the recommended daily intake for healthy, non-pregnant adults is approximately 150 µg per day. Given the potential negative effects of inadequate iodine nutrition, it is important to adopt preventive measures and nutritional monitoring. Among the possible strategies, salt iodization stands out; it is already mandatory in school cafeterias in Portugal, constituting a significant step in promoting adequate intake of this micronutrient in the population.

Keywords: iodine, public health, iodine deficiency, nutrition, Portugal

Discipline: Human Nutrition

Professor: Bárbara Beleza

Degree: Dietetics and Nutrition

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WATER AND ELECTROLYTE BALANCE IN PREGNANCY

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Background: Water and electrolyte balance are closely interrelated and essential concepts. Water is vital for life, accounting for more than half of body weight and performing multiple functions, including the regulation of electrolyte balance. Electrolyte balance refers to the maintenance of appropriate concentrations of charged minerals.

Aim: This study aims to examine the importance of mineral concentration during pregnancy through electrolyte balance and the role of water in this process.

Methods: A comprehensive search was conducted in PubMed® using the keywords "water," "electrolyte balance," and "pregnancy". Initially, a large number of articles were identified; after applying quotation marks and parentheses, 3 relevant articles were selected, with no date restrictions applied.

Results: During pregnancy, electrolytes undergo specific and dynamic regulation. There is progressive sodium (Na^+) retention, essential for extracellular volume expansion, while potassium (K^+) remains relatively stable due to renal regulation. Despite this, plasma sodium concentration slightly decreases due to hemodilution. Additionally, some electrolytes are transferred to the fetus, indicating that maternal electrolyte balance is adjusted to support fetal development.

Conclusion: Pregnancy involves adaptive changes in fluid and electrolyte balance, including sodium retention, hemodilution, and potassium regulation. These physiological adjustments promote maternal volume expansion and adequate perfusion, ensuring fetal development and maintaining homeostasis.

Keywords: Walter; Electrolyte balance; Pregnancy

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B-COMPLEX VITAMINS AND ENERGY METABOLISM

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Background: B vitamins are a group of water-soluble micronutrients essential for energy metabolism, acting as coenzymes in biochemical reactions.

Objectives: Describe the role of B vitamins in energy metabolism, highlighting the biochemical mechanisms involved and the reactions that produce energy.

Methodology: A Pubmed literature review based on review articles that address the role of B vitamins in energy metabolism, integrating different perspectives on their mechanisms of action.

Results: The B complex vitamins, including B1, B2, B3, B5, B6, B7, B9, and B12, act as enzymatic cofactors in various stages of energy metabolism. Vitamin B1 participates in the conversion of pyruvate to acetyl-CoA, facilitating entry into the Krebs cycle. Vitamins B2 and B3 are involved in the formation of FAD/FADH2 and NAD/NADH and are fundamental in oxidation-reduction reactions and the electron transport chain. Vitamin B5 is part of coenzyme A, essential in fatty acid metabolism, while vitamin B6 is involved in amino acid metabolism. B7 participates in carboxylation reactions, vitamins B9 and B12 play important roles in ADN synthesis and cellular metabolism.

They participate directly in metabolic pathways such as glycolysis, Krebs cycle, and the respiratory chain, and are crucial for the efficient production of energy, especially under conditions of high metabolic demand.

Conclusion: B vitamins play an essential role in energy metabolism, acting as coenzymes that allow for the integration and efficiency of key metabolic pathways. Adequate intake of B vitamins is fundamental to ensure energy production and metabolic balance, contributing to the proper functioning of the body.

Keywords: Keywords: B-complex vitamins; Energy metabolism; Coenzymes; Energy production

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PHYSIOLOGY OF APPETITE AND ITS EFFECTS

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Background: The physiology of appetite is a complex, homeostatic system regulated by the brain, primarily the hypothalamus integrating signals from the gut and adipose tissue.

Objectives: The aim of this work was to characterize the influence of the physiology of appetite and its relationship with dopamine, and the other was to define better what physiology of appetite stands for.

Methodology: We carried out a search on ScienceDirect. Search retrieved 2 results, and we've selected 2 papers.

Results: Appetite is regulated through an integration of brain activity, hormonal signals, and physiological processes. The brain combines information about food taste, digestive activity, and metabolic state to determine when and how much we eat.

A key component on this system is dopamine which is involved in motivation rather than physical hunger. Dopamine acts in the brain's reward system to increase the desire to consume food, especially highly palatable options. It reinforces eating behavior by linking certain foods with pleasurable experiences, making us more likely to repeat them.

Appetite is influenced by hormones such as ghrelin and leptin who play a very important role in one's hunger and satiation. External factors like environment, habits, and experiences also shape our eating habits.

Conclusion: This research shows that the appetite's physiology must be seen as an integrated system where the hypothalamus and peripheral hormones regulate energy needs (homeostasis), dopaminergic reward circuits determine the hedonic value of food, and cognitive processes modulate the decision to eat.

Keywords: dopamine; appetite; eating habits; hunger; satiation

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FAT-SOLUBLE VITAMINS (A, D, E, K): ROLES, TRANSPORT AND TOXICITY

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Background: Fat-soluble vitamins (A, D, E, K) are essential micronutrients involved in key physiological processes, including vision, immune function, antioxidant protection, bone metabolism, and blood coagulation. Their lipophilic nature influences their absorption, transport, storage, and toxicity, and imbalances may occur in populations with malabsorption or inadequate intake.

Objectives: To review the biological roles, dietary sources, transport mechanisms, and toxicity risks of fat-soluble vitamins.

Methodology: A literature review was conducted using the PubMed and Google Scholar databases. The search included the terms (“fat-soluble vitamins” OR “vitamin A” OR “vitamin D” OR “vitamin E” OR “vitamin K”) AND (“metabolism” OR “transport” OR “absorption” OR “toxicity”). Articles were selected based on relevance, human physiology, and publication in scientific journals. No time restriction was applied.

Results: Fat-soluble vitamins are absorbed in the small intestine with dietary lipids, requiring bile salts and digestive enzymes for micelle formation. They are transported in the bloodstream via lipoproteins or binding proteins and stored mainly in the liver and adipose tissue. Vitamin A supports vision and gene regulation; vitamin D regulates calcium and phosphate homeostasis; vitamin E acts as an antioxidant; and vitamin K is essential for blood coagulation and bone metabolism. Impaired lipid absorption can reduce bioavailability, while excessive intake may lead to hypervitaminosis.

Conclusions: Adequate intake of fat-soluble vitamins is essential for health. Both deficiency and excess can lead to clinical consequences, reinforcing the importance of balanced intake. These findings highlight the importance of public health strategies, including nutritional education, food fortification, and supplementation in at-risk populations.

Keywords: Fat-soluble vitamins; Vitamin A; Vitamin D; Vitamin E; Vitamin K

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IODINE IN THE DIET OF THE PORTUGUESE POPULATION: CURRENT SITUATION AND HEALTH IMPACTS

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Background: Iodine plays an extremely important role in thyroid function; this mineral is essential for metabolism and the body's development. Iodine deficiency, whether severe or moderate, can have harmful effects, particularly during pregnancy, and may cause impairments in children's cognitive development.

Objectives: This work aimed to characterize iodine status in the Portuguese population and its health impacts.

Methodology: Search was conducted in Pubmed with key words such "iodine in Portugal" and in an epidemiological bulletin published by the National Institute of Health Dr. Ricardo Jorge (INSA).

Results: Portugal, despite its proximity to the sea, has an insufficient intake of iodine in the population's diet. Recent studies have drawn attention to this situation, highlighting the possibility that it is a significant public health issue. Currently available data indicate that iodine intake nationwide is around the minimum recommended level. When compared to data from the 1980s, a significant increase in the intake of this micronutrient is observed. According to the recommended daily intake for healthy, non-pregnant adults is approximately 150 µg per day.

Conclusion: Given the potential negative effects of inadequate iodine nutrition, it is important to adopt preventive measures and nutritional monitoring. Among the possible strategies, salt iodization stands out; it is already mandatory in school cafeterias in Portugal, constituting a significant step in promoting adequate intake of this micronutrient in the population.

Keywords: Keywords: iodine, public health, iodine deficiency, nutrition, Portugal

"HIDDEN HUNGER" IN OBESOGENIC ENVIRONMENTS

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Background: Environmental factors greatly influence an individual's health-related choices, from nutrition to physical activity levels. An obesogenic environment promotes poor nutritional decisions, increasing obesity risk. Individuals in these environments may consume excess calories yet lack essential micronutrients, causing hidden hunger.

Objectives: To analyze the role of an obesogenic environment in the coexistence of obesity and micronutrient deficiency.

Methodology: Research was conducted in PubMed for the keywords "obesogenic environment" AND "nutrient", "hidden hunger", "micronutrient deficiency" AND "obesity" and in ScienceDirect for the keywords "obesity" AND "malnutrition". A total of 10 papers were selected.

Results: Malnutrition in obesity includes inadequate intake, defective storage and absorption of nutrients, increasing the risk of metabolic disorders and chronic diseases.

The most common micronutrient deficiencies found in obesity are vitamin A; B vitamins (B1, B9, B12), important for energy metabolism and red blood cell synthesis; vitamin D, essential for calcium homeostasis and bone health; vitamin C; vitamin E; and minerals such as iron, important for oxygen transport and immune function, as well as calcium and magnesium, fundamental to glucose metabolism and insulin action.

Conclusion: Managing hidden hunger in obesity requires a holistic approach. It must begin with nutrition education and with public policies, recognising that the environment influences dietary and lifestyle choices. It is essential to ensure access to nutritious foods and promote balanced diets, prioritising a variety of fruits and vegetables, lean meats, dairy products, and whole grains, and ensuring an appropriate proportion of fatty acids, thereby helping tackle the obesity epidemic.

Keywords: obesity; malnutrition; micronutrient deficiency; obesogenic environments; hidden hunger

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LIPIDS AND CARDIOVASCULAR HEALTH

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Background: Lipids are essential biomolecules involved in energy storage, cellular structure and metabolic regulation. However, changes in lipid profile, particularly elevated low-density lipoprotein (LDL) cholesterol and triglycerides, and reduced high-density lipoprotein (HDL) cholesterol, are strongly associated with the development of cardiovascular diseases (CVD). These imbalances contribute to atherosclerosis, a chronic inflammatory process characterized by plaque formation in arterial walls, leading to increased cardiovascular risk.

Objective: To analyze the role of lipids in the development of CVD, focusing on their physiological functions, impact on atherosclerosis and implications for prevention and treatment.

Methodology: Search was conducted in PubMed addressing papers on lipid metabolism, cardiovascular risk factors and therapeutic interventions. Studies evaluating lipid profiles, mechanisms of atherosclerosis and the effects of pharmacological and lifestyle interventions were considered (n=10).

Results: High LDL cholesterol plays a central role in atherogenesis by promoting lipid accumulation and inflammation in arterial walls. In contrast, HDL cholesterol exerts a protective effect through reverse cholesterol transport. Triglycerides are also associated with increased cardiovascular risk. Interventions such as lipid-lowering therapies and dietary modifications have demonstrated effectiveness in reducing cardiovascular events. However, variability in study populations and methodologies may influence outcomes.

Conclusion: Lipid profile management is crucial in the prevention and control of CVD. Strategies combining lifestyle changes and pharmacological treatment are essential to reduce cardiovascular risk and improve overall health outcomes.

Keywords: Cardiovascular diseases; Lipids; high-density lipoprotein; low-density lipoprotein

ZINC, COPPER, AND SELENIUM: STRUCTURAL FUNCTIONS, SOURCES, ANTIOXIDANT ROLE AND FOOD REGIMENS

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Background: Trace elements such as zinc, copper, and selenium play an important role in oxidative processes. We chose this topic because micronutrients, especially minerals, are becoming increasingly recognized as essential for a healthy diet and their deficiency can lead to serious health problems.

Objectives: The study aimed to understand whether the type of diet influences the levels of these essential trace elements in the body, as well as the potential nutritional risk associated.

Methodology: Search was conducted at PubMed with keywords “omnivorers”, “zinc”, “selenium”,” copper”, “nutritional deficiency”, “plant-based diet”, and one study was selected.

Results: A study conducted with 18 to 69 years-old individuals found that vegetarians and vegans have lower selenium and zinc levels than omnivores, while copper levels remained similar, highlighting potential nutritional risks in plant-based diets. Since zinc comes from animal foods, vegans showed lower levels as well as selenium, which also presented lower levels in vegetarians, however, their blood levels were not significantly reduced. Finally, copper had no significant changes, and individuals who eat more foods of plant origin has adequate or even higher levels than omnivores.

Conclusion: Although vegetarian and vegan diets may appear beneficial for health, our results showed that they can lead to deficiencies in these minerals, which may weaken the immune system, increase oxidative stress, and cause fatigue. Therefore, monitoring and, if necessary, supplementation of selenium and zinc is recommended for individuals on plant-based diets.

Keywords: Diet, Zinc, Copper; Selenium