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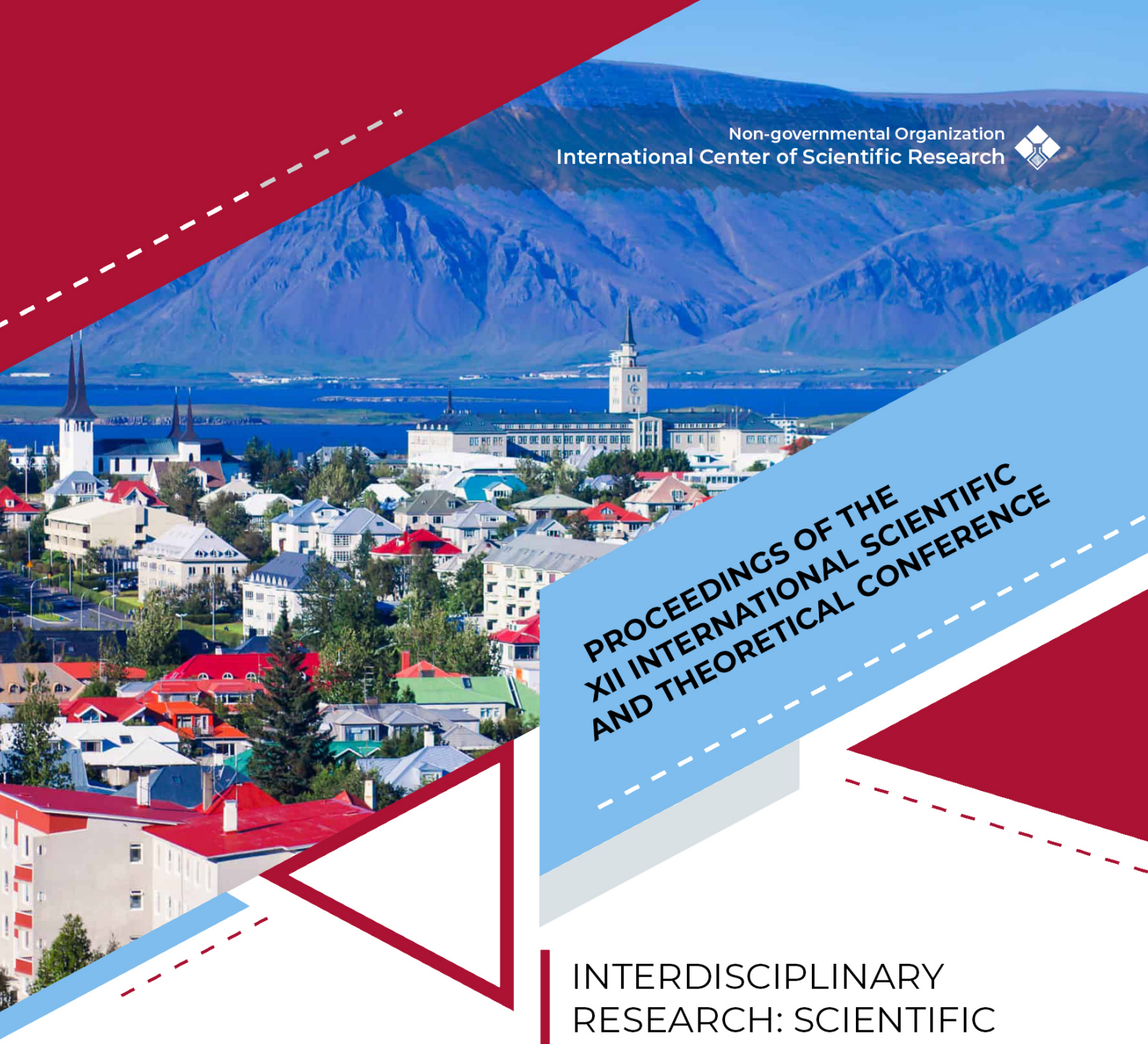

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MEDICAL SCIENCES AND PUBLIC HEALTH

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CURRENT METHODS FOR EXPERIMENTAL MODELING OF TRAUMATIC BRAIN INJURY IN MICE AND RATS

Traumatic brain injury (TBI) remains one of the leading causes of mortality and long-term disability among young individuals worldwide. Despite significant advances in clinical medicine, the mechanisms underlying post-traumatic morphological and functional alterations in the brain and peripheral organs remain insufficiently understood [1, 2]. Consequently, experimental models of TBI in laboratory animals have become indispensable, as they enable the reproduction of distinct types of brain injury, investigation of pathophysiological mechanisms, and evaluation of potential therapeutic strategies.

In addition to direct alterations within the central nervous system, recent experimental studies have demonstrated that traumatic brain injury induces a systemic response associated with secondary morphological changes in peripheral organs. In particular, experimental models of mild TBI are associated with structural alterations in the liver and kidneys, manifested by changes in tissue histoarchitecture, signs of microcirculatory disturbances, degenerative processes, and remodeling of morphometric parameters [3, 4]. These findings support the necessity of comprehensive investigation of TBI consequences not only at the cerebral level but also in the context of systemic effects of traumatic injury throughout the body [3, 4].

At present, laboratory rodents (mice and rats) are the most commonly used species for experimental modeling of TBI because of their availability, well-

characterized physiology, potential for experimental standardization, and broad range of available outcome assessment methods [1 – 7].

Based on recent experimental evidence, four of the most established and widely used approaches for modeling TBI can be distinguished. One of the most commonly applied methods is the Controlled Cortical Impact (CCI) model. This technique involves delivering a controlled mechanical impact to the exposed dura mater following craniotomy using a specialized device. The main advantages of this model include high reproducibility and precise control of injury parameters [2, 6].

Another widely applied approach is the Fluid Percussion Injury (FPI) model, which induces diffuse brain injury associated with axonal damage and neuroinflammatory processes accompanied by glial activation [7, 8].

For modeling closed TBI, one of the most frequently used approaches is the Weight-Drop Model, which reproduces a closed head-injury and is widely used to investigate mechanisms of brain damage, edema formation, inflammatory responses, and the development of neuroprotective strategies [6, 9].

Increasing attention has recently been focused on models of Repeated Mild Traumatic Brain Injury (rmTBI), which allow the investigation of cumulative effects of repeated injuries and delayed morphological alterations. These models simulate conditions observed in athletes, military personnel, and individuals exposed to recurrent head impacts and therefore play an important role in understanding long-term consequences of repetitive brain trauma [5, 10].

Thus, contemporary methods for modeling TBI in mice and rats provide a robust experimental platform for further investigation of the pathogenesis of traumatic brain injury and for the development of novel therapeutic strategies.

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