

Investigating the impact of routine physical activity on the crystallogenic properties of saliva in elderly individuals

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Abstract:

The exploration of the metabolic status in the elderly using non-invasive monitoring techniques for biological fluids remains a pertinent area of study. The correlation between crystallogenic parameters in biological fluids and the regular physical activity of individuals has not been comprehensively examined in the past. The objective of this research is to conduct a comparative evaluation of the physical and chemical properties of saliva in elderly individuals based on their regular physical training. **Materials and methods.** The study involved 94 participants with a mean age - of 64.7 ± 2.9 years. The cohort comprised 49 individuals actively participating in routine physical activity (main group), while the remaining 45 elderly participants did not engage in regular physical training (control group). All patients were examined at 2 control points: upon inclusion in the research project and 6 months after its completion. The crystallogenic properties of saliva were tested at these two control points. A proprietary system of semi-quantitative parameters for the description of crystalloscopic facia was used. **Results.** It was found that after 6 months of observation in both groups, the value of the crystallization index, which characterizes the number of crystalline elements in a dried saliva microslide, and the structural index, which indicates the complexity of their structure, decreases. In addition, a decrease in the area index of the edge protein part of the sample and an increase in the destruction degree of crystals were observed. These changes indicate a disturbance in the metabolic status of elderly people. All these negative changes were most pronounced only in elderly people who did not engage in sports, $p < 0.05$. **Conclusions.** The results of the study indicate that metabolic disorders, which indicate the aging of the body, are significantly more pronounced in the group of patients who ignore regular physical activity. The study results can be used to promote regular physical activity.

Key Words: saliva, elderly people, aging, physical exercise

Introduction

In recent decades, the proportion of elderly and senile people in the population structure of many countries around the world has increased. Scientists believe that one of the reasons for this demographic situation is the improvement in the quality of life of a significant proportion of the world's population.

Regular aerobic exercise is known to be an effective method of increasing physical and mental performance, improving exercise tolerance and increasing the adaptive reserves of the human body at any age (Campos et al, 2023). A key role in increasing the body's reserve capacity is played by improving the activity of the cardiovascular system (Shinichiro Morishita et al., 2021), as the main functional system. It is believed that it limits the volume and intensity of physical activity.

The positive effect of physical exercise on the body is ensured by a change in metabolism, both at the level of muscle tissue and the body as a whole, and is largely independent of a person's age (Moggetti et al., 2016). Researchers suggest that physical training may promote a favourable metabolic response, thereby slowing the ageing process (Qiu et al., 2023). However, there are relatively few studies in the scientific literature that address this issue (Mendonca et al., 2016; Pearlmutter et al., 2020).

Despite the large body of literature on the positive effects of physical activity on the human body, physical activity levels are still low among different population groups in different countries. A World Health Organization report shows that in most countries, more than a third of the population does not meet the required level of daily physical activity (WHO Physical activity Fact sheet, 2018). According to Rogers et al. (2020), in the UK, around a third of the population are not in good physical condition. Hypokinesia is particularly

detrimental to the health of older people, who are at high risk of COVID infection (Huang et al., 2020), the relevance of which remains pandemic. Therefore, the promotion of physical activity in populations of different ages seems timely and crucial.

When using regular physical training, it becomes necessary to assess the dynamics of the state of the adaptive reserves of the body. In this case, non-invasive methods for monitoring the state of the body's reserve capabilities have advantages. The results of observations using such methods allow changes to be made in the planning and organisation of the educational and training process (Budzyn et al., 2018), and the use of various types of rehabilitation measures or procedures (Chiriac Paul Bogdan et al., 2021).

One of the promising non-invasive areas in the field of physical culture and sports is the crystalloscopic study of biological fluids of the body, as an indicator of the body metabolism (Jordanishvili, 2019). The method is based on studying the intrinsic crystal-forming ability of human serum, blood plasma or salivary fluid. Some authors have presented data on the possibility of using saliva diagnostics to assess the metabolic status of a person (Pérez-Gómez et al., 2021).

In previous publications, we have justified the use of biocrystallomics methods for this purpose, which allow us to integrally describe the composition and properties of saliva (Martusevich et al., 2022a; Martusevich et al., 2022b). However, the issues of using optimal methods for studying the crystallogenic properties of biological fluid in elderly people under conditions of different levels of physical activity remain incompletely studied. Studying this issue will allow us to trace the dynamics of the dependence of reserve capabilities on the level of physical activity.

This will make it possible to make adjustments to the physical training programmes for elderly people, to specify medical, biological, and pedagogical methods for restoring their body, which will increase the effectiveness of the physical fitness of those involved. The obtained results can be used to promote physical activity among the population, especially among elderly people.

Research aim. To provide a comparative assessment of the physical and chemical parameters of the saliva of elderly people depending on their regular physical training.

Material & methods

94 people (mean age – 64.7 ± 2.9 years) without severe chronic diseases (main medical group) took part in the experimental study. This contingent included 49 people (Main group) engaged in regular physical training on the basis of Sport and Recreation Center in the city of Nizhny Novgorod (Russia). A control group (CG) of elderly people ($n=45$) did not engage in regular physical exercise. All patients were examined at 2 control points: upon inclusion in the experimental study (at the beginning of training - for the main group) and after 6 months of performing regular aerobic physical activity. At each control point, saliva samples were taken from the subjects under standard conditions (at the same time, 2 hours after eating, without salivary stimulants). The course of regular physical training included swimming, Nordic walking, and various sets of physical exercises, conducted under the guidance of an instructor at the Sport and Recreation Center. The training frequency was 3 sessions per week, each lasting 45 minutes. The intensity of physical activity was selected individually and depended on the level of physical condition, physical fitness and somatic health of the person, taking into account existing age restrictions.

Microslides (crystalloscopy facia) were prepared from each saliva sample by applying 100 μ l drops to a glass slide and then freely drying them (Martusevich et al., 2022a; Martusevich et al., 2022b). The crystallization results were assessed using microscopy at 60x magnification. The crystallograms were described using their proprietary system of semi-quantitative indicators, the main ones being crystallizability (Cr), structural index (SI), facia destruction degree (FDD) and protein margin zone (Mz), (Martusevich et al., 2022a; Martusevich et al., 2022b).

All study participants signed informed consent to participate in it. This study protocol was approved by the ethical committee of the Lobachevsky University of Nizhny Novgorod. The conducted research does not contradict the principles and ethical standards of the 2008 Declaration of Helsinki, which apply to biomedical research.

The obtained digital research data were processed in accordance with generally accepted statistical calculation methods. We used the licensed program Statistica 6.0. Differences at $p < 0.05$ were considered statistically significant.

Results

At the beginning of the experimental study, it was established that the crystallogenic characteristics of the mixed saliva sample of people from both groups were identical in terms of the parameters under consideration, $p > 0.05$. Further examination of saliva samples revealed a deterioration in the qualitative and quantitative composition of the samples in all examined individuals. This was noted visually from the crystalloscopic picture of the studied biological fluid. At the same time, the pace of development of these negative trends was not the same, Figure 1.

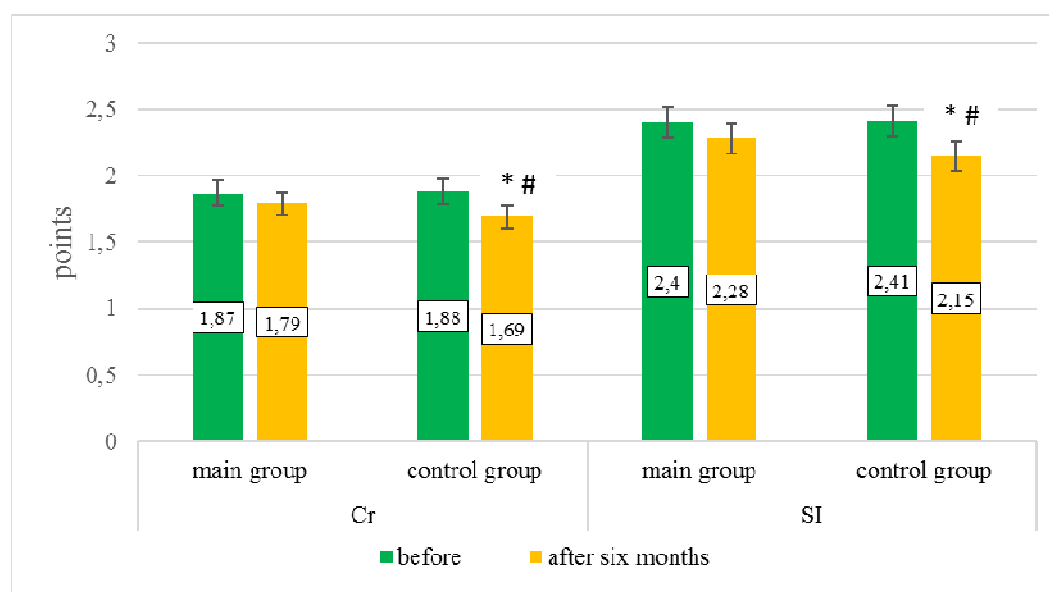


Fig. 1. Dynamics of crystallizability (Cr) and structure index (SI) in saliva crystallograms from elderly people with various motor modes (* - differences to baseline level are stastically value, $p < 0.05$; No - differences to main group are stastically value, $p < 0.05$)

Thus, according to the quantitative indicator of crystallograms (Martusevich et al., 2022a) - crystallizability - the value of the indicator among representatives of the main group decreased by 4.3% (from 1.87 to 1.79 points), without reaching a statistically significant drop. On the contrary, in the control group the decrease in Cr was 10.1% (from 1.88 to 1.69 points) relative to the initial value, $p < 0.05$. This decrease in the Cr value was 2.5 times greater than in the main group.

A similar trend was revealed in relation to the main qualitative criterion of crystallization - the structural index (SI). It was found that the value of this indicator significantly decreased by 5.7% (from 2.28 to 2.15 points) to the initial level only in people included in the control group, $p < 0.05$. In the main group, no decrease in the crystallization index was recorded.

Depending on facia destruction degree (FDD) and the severity of the marginal (protein) zone (Mz), similar dynamics were recorded, indicating statistically significant changes in parameters between control points of the study in the main and control groups, Figure 2.

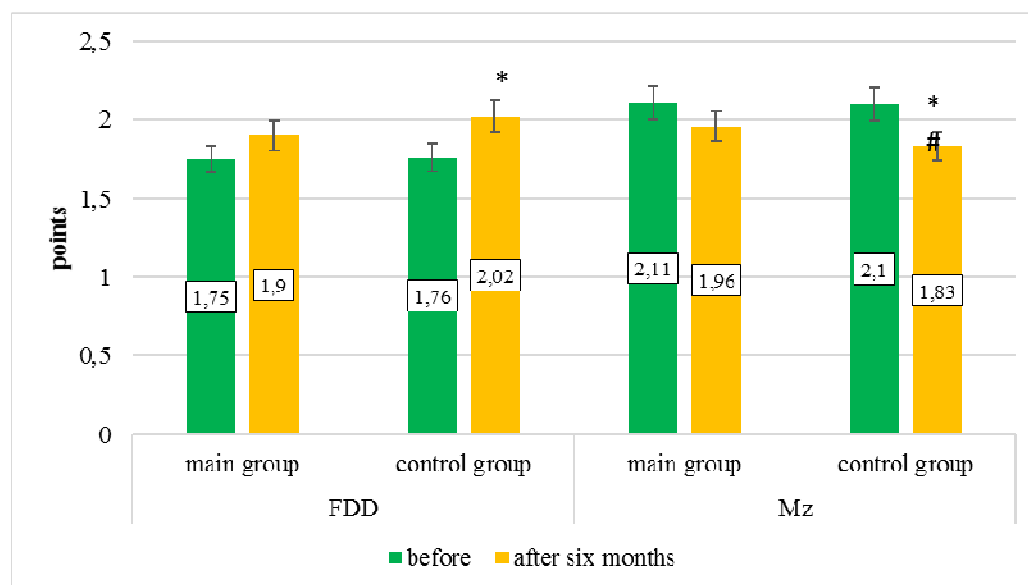


Fig. 2. Dynamics of facia destruction degree (FDD) and clarity of marginal zone (Mz) in saliva crystallograms from elderly people with various motor modes (* - differences to baseline level are stastically value, $p < 0.05$; No - differences to main group are stastically value, $p < 0.05$)

An increase in the value of the FDD was established in both observation groups. A significant increase in the value of this indicator was found to be 14.7% only in the control group from 1.76 to 2.02 points, $p < 0.05$. At the end of the experimental study, a decrease in the severity of the marginal zone was found in both observation groups. A significant decrease in the value of the Mz indicator is recorded only in the control group. There was a decrease in the value of the indicator in this group by 12.8% from 2.1 to 1.83 points, $p < 0.05$.

These trends in the process of crystallization of saliva in elderly people were manifested in an increase in the number of destroyed crystalline elements of the facial surface (FDD) in the micropreparation, the deepening of destructive changes in them, as well as a narrowing of the facial marginal zone (Mz). These changes indicate a significant decrease in the concentration of proteins of the native conformation in biological fluid. At the same time, the final values of the indicators were worse in the control group compared to the main group of patients who performed regular physical activity. This may indicate a protective anti-aging effect of regular physical exercise. This is indicated by a decrease in the rate of natural metabolic changes. Accordingly, this is reflected in changes in the composition of biological fluids, including saliva.

Dicussion

It is known that the ageing processes of the human body are accompanied by a complex of metabolic and functional changes at the cellular, tissue and organ levels (Hemmeter & Ngamsri, 2022). These changes are manifested in progressive disturbances in the component composition and physical and chemical properties of biological body fluids (Valenzuela et al., 2019). Currently, various strategies for slowing down the body's involutionary processes are being actively considered and studied (Mendonca et al.), including those based on the use of pharmacological agents or dietary supplements (Pirmohamed, 2023). However, scientists believe that regular physical activity is the most physiologically acceptable option for extending human life (Bullo et al., 2015). Despite the clear positive effects of exercise that scientists have established, there is relatively little information about its metabolic effects on elderly people. Therefore, there are insufficient pathogenic justifications for their use to reduce the rate of human ageing. At the same time, most gerontologists focus on the positive effect of physical training on the manifestations of depression and anxiety disorders of the central nervous system (López-Torres Hidalgo et al., 2019). In addition, the antidepressant and anxiolytic effects of the studied factor have been shown in several randomised clinical trials (Ravari et al., 2019; Song, 2019). Training has also been shown to have a positive effect on sleep quality and insomnia (Moreno Reyes et al., 2020). This ensures an extension of the time of full "functional longevity" of a person (Kazeminia et al., 2020).

There is relatively little evidence regarding the metabolic rationale for the role of physical activity. Only a few studies indicate successful correction of oxidative stress by regular exercise (Silva et al., 2019; Collado-Mateo et al., 2021). With this in mind, we analysed the dynamics of the physical and chemical characteristics of the saliva of elderly people depending on whether they regularly engage in physical activity. To assess the parameters of a biological fluid, a method of studying its crystallogenic activity was chosen. This method integrally describes its physical and chemical characteristics. The study found that in individuals who lacked sufficient regular physical activity, the crystallogenic properties of saliva significantly deteriorated. This is evidenced by a decrease in crystallization and structure index of saliva samples of elderly people. In addition, in patients included in the control group, crystallographs of biological fluid showed an increase in the fascia destruction degree, as well as clarity of the marginal zone of micro-preparations. This indicates a decrease in the number of proteins that have retained their native structure and conformation. However, amongst elderly people regularly engaged in physical activity, after 6 months, all studied salivary parameters were recorded to remain at the initial level by the time the experimental study was completed. Our research results confirm the opinion of other scientists regarding the possibility of using non-invasive methods for studying biological fluids to assess the metabolic status of an elderly person (Jordanishvili, 2019; Pérez-Gómez et al., 2021).

Our research results expand scientific knowledge in the field of crystallogenic properties of biological fluids of the human body. They can be used in further scientific research and also have applied value in the field of physical education and sports. In the future, research is required aimed at developing effective regimes of personalised educational and training sessions for the elderly.

Conclusions

Our experimental study established a statistically significant relationship between the crystallographic parameters of the saliva of elderly people and their regular physical activity. Over the course of 6 months of observation, patients who did not have regular physical training in their lifestyle showed a significant deterioration in the physical and chemical parameters of saliva compared to patients who regularly performed aerobic training exercises. These data suggest that regular physical training can slow down the rate of deterioration of the body's metabolic status and ageing of the body. The obtained materials are a significant basis for promoting regular physical activity among various population groups.

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Conflicts of interest. The authors declare no conflict of interest.

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