



## ARTÍCULOS

UTOPIA Y PRAXIS LATINOAMERICANA. AÑO: 25, n° EXTRA 12, 2020, pp. 363-372  
REVISTA INTERNACIONAL DE FILOSOFÍA Y TEORÍA SOCIAL  
CESA-FCES-UNIVERSIDAD DEL ZULIA. MARACAIBO-VENEZUELA  
ISSN 1316-5216 / ISSN-e: 2477-9555

### Health Risk Analysis in Sports Activities in the Russian Northern Region

*Análisis de riesgos a la salud en actividades deportivas en la región norte de Rusia.*

ROMAN VIKTOROVICH KUCHIN

<https://orcid.org/0000-0002-5478-4846>

[kuchin\\_r@mail.ru](mailto:kuchin_r@mail.ru)

Yugra State University, Russia

Este trabajo está depositado en Zenodo:  
DOI: <http://doi.org/10.5281/zenodo.4280171>

#### ABSTRACT

The purpose of this review is to analyze available literature data describing the features of the human body functional systems response in sports activities in the northern region based on the example of KMAO-Yugra (Russia). According to the results of the literature sources discovered, we described changes in anthropometric data, shifts in the cardiovascular, respiratory, musculoskeletal and immune systems, as well as in hematopoiesis, psyche, and metabolism characteristic of sports activities in the northern regions. Therefore, there are vulnerable groups put at a higher risk of disrupting the processes of adaptation to physical exercises in the northern region conditions.

**Keywords:** Adaptation, health, northern region, Russia, sport.

#### RESUMEN

El propósito de esta revisión es analizar los datos de la literatura disponible que describen las características de la respuesta de los sistemas funcionales del cuerpo humano en las actividades deportivas en la región norte con base en el ejemplo de KMAO-Yugra (Rusia). De acuerdo con los resultados de las fuentes bibliográficas descubiertas, describimos cambios en los datos antropométricos, cambios en los sistemas cardiovascular, respiratorio, musculoesquelético e inmunológico, así como en la hematopoyesis, psique y metabolismo característicos de las actividades deportivas en las regiones del norte. Por tanto, existen grupos vulnerables que corren un mayor riesgo de perturbar los procesos de adaptación a los ejercicios físicos en las condiciones de la región norte.

**Palabras clave:** Adaptación, deporte, región norte, salud, Rusia.

Recibido: 17-09-2020 Aceptado: 05-11-2020



## **INTRODUCTION**

Theoretical aspects of the physiology of sports activity (for different sports), in the conditions of certain external natural and climatic factors of the living environment, when the human body experiences both physical exercises and the impact of special climatic and geographical conditions of the environment, are being actively studied (Sashenkov et al.: 2012).

It is noted that under these conditions, changes in some body systems are more or less of the same type and depend poorly on the kind of sports activity, while changes in the other ones depend significantly on the kind of sports. Functional changes in some body systems in sports activities in the northern region contribute to prevention of the pre-pathological conditions onset typical for the region's residents, while in the other systems, the adaptation stress is aggravated (Kuchin&Stogov: 2019, pp.72-78).

In this regard, the purpose of this review is to analyze available literature data describing the features of the human body functional systems response in sports activities in the northern region based on the example of KHAMO-Yugra (Russia).

## **METHODOLOGY**

The search for literature data was performed in PubMed (<https://pubmed.ncbi.nlm.nih.gov/>) and elibrary (<https://www.elibrary.ru/>) scientific literature open electronic databases. Keywords: the North, sport, physiology. The search depth covers 15 years.

## **RESULTS**

Anthropometry. It is a known fact that there is a strong relation between the anthropometric and functional indicators of the body, as well as between the intensity and nature of physical exercises. Available research in this field shows that the physical development of young males and females, northern migrant descendants, is under the combined effect of both the ecological environment and the amount of physical exercises being performed. Consequently, the formation of morphological male and female types, migrant descendants, distinguishes from the physical status of those people originating from other natural and climatic zones. In particular, it was established that the body shape of young males and females, migrant descendants, those not involved in sports activities, for the most part has a high occurrence of asthenic body features, while those young people involved in sports activities form a normosthenic type and a low occurrence of other types (Koinosov et al.: 2014, pp.88-91).

The features of the somatotype formation that distinguishes its formation and development from those young population originating from other climatic zones may be attributed to a delay in the migrant children body development during the childhood and a relatively rapid passage through lags in development stages in adolescence, achieving morphofunctional maturity of vital body systems by 17-18 years old (Koinosov: 2008).

It has been certainly established that adipose tissue content and body mass index in young population in the northern regions involved in sports activities are estimated to be lower than in their northern peers not involved in sports activities. The absolute muscle component value is also considerably higher in a group of young people involved in sports activities (Filippova: 2016, pp.235-241). Similar somatotype changes are also observed in young population of indigenous peoples of the region who involved in sports activities (Koinosov et al.: 2014, pp.62-65).

In general, a quite clear idea has now been formed about the fact that the anthropometric indicator changes in northerners have the same orientation, as the one described above, and do not depend on sports specialization. However, it is worth noting that 7-years-old children living in the north conditions show the delay

in growth processes (both boys and girls) as a result of sports training, which is indicative of excessive physical exercises for this age period (Busheva&Auster: 2012, pp.44-46).

Nonetheless, based on the body of the data presented, one can conclude that sports activities have a beneficial effect on the morphofunctional development of children and young individuals in KMAO-Yugra, both migrant descendants and indigenous peoples of the region.

Cardiovascular system (CVS). As the literature data shows, the cardiovascular system response to sports activities in the northern region residents is quite unidirectional. Numerous studies show that individuals involved in sports activities, compared to their peers not involved in sports activities, experience a decrease in average heart rate and blood pressure (systolic, diastolic, average), systemic and peripheral blood flow improvements, increase in stress test resistance and in physical performance (Green& Smith: 2018). In general, occurring changes contribute to the prevention of cardiovascular changes in individuals involved in sports activities (Kralova et al.: 2015, pp.192-198).

It is important to note that these changes do occur in nearly all sports (cyclic and acyclic, winter and summer, indoors and outdoors). The features of the cardiovascular system functioning revealed in young population involved in sports activities in the North are functional and agree with the results of studies performed in the athletes living in Central Russia (Pogonysheva et al.: 2015, pp.218-224).

Nevertheless, some authors observe certain alterations and deviations in the CVS functioning in individuals involved in sports activities. In particular, representatives of certain sports have negative changes that can trigger disorders in this given body system (Manou-Stathopoulou et al.: 2015, pp.808-820).

It was also noted that extra stress put on the CVS in individuals involved in sports activities in the region can lead to increased probability of the transition from adaptive changes to pathological ones. Thus, females aged 10-11 years old, involved in acrobatics in the climatic conditions of KMAO-Yugra, have revealed cardiovascular abnormalities with the increased level of adaptation mechanisms stress and the pathology transition risk (Govorukhina&Nezhinskaya: 2017, pp.8-13).

Thus, we can conclude that changes in the CVS occurring in individuals living in the region and involved in sports activities are mainly positive and do not depend on the type of sports activity. In general, this helps to improve their adaptive resources of the body to the living conditions. However, some instability in cardiovascular system parameters can cause risks of functional disorders in vulnerable groups involved in sports activities in KMAO-Yugra; this requires continuous CVS monitoring.

Respiratory system. Changes in the respiratory system in individuals involved in sports activities and living in the northern regions are associated with the increased functional power and efficiency of the system. It states that individuals involved in sports activities (regardless of sports specialization), in contrast to individuals not involved in sports activities, show increased volumetric and speed rates of pulmonary ventilation, as well as increased chest capacity (Nikitina et al.: 2014, pp.1540-1545). The dynamics of changes observed in the respiratory system is also typical for the indigenous residents of the region involved in sports activities Blinnikova et al.: 2013, pp.9-13).

Despite the positive aspects, negative functional changes in the respiratory system are also evident. Thus, it has been shown that individuals involved in winter sports in the northern region are at a higher risk of respiratory system obstructive disorders seemingly associated with outdoor training regimes in colder weather, in contrast to the conditions in temperate latitudes (Kippelen et al.: 2015, pp.165-182).

In general, changes in the respiratory function in individuals involved in sports activities in KMAO-Yugra are positive and aimed at increasing the body resistance to climatic and geographical conditions of the region. The presence of vulnerable groups (individuals involved in winter sports) also leads to the need for additional biomedical monitoring of the respiratory system function during winter sports activities in the region.

Blood and hematopoiesis. Following the analysis of the available literature data, it was found that there were no credibly significant changes in blood indicators in individuals involved in sports activities and living in KMAO-Yugra, compared to their peers not involved in sports activities, their average values are within normal

physiological range (Gubina&Koinosov: 2016, pp.65-67). However, it is noted that sports activities lead to changes that are not observed in residents of temperate latitudes involved in sports activities. Thus, individuals involved in sports activities in the northern region show considerable seasonal variations in hematological indicators. In particular, during longer daylight hours, young male athletes, KMAO-Yugra residents, showed increased red blood cells, hemoglobin and hematocrit, and females showed increased hemoglobin, mean cell hemoglobin and red blood cells hemoglobin saturation, which was not observed in winter and spring time (Rutkovskiy et al.: 2018, pp.48-52).

Intense physical exercises lead to the development of hypercoagulation, which increases the risk of thrombotic complications (Van der vorm et al.: 2018, pp.710-722).

Immune system. Immunological aspects of the physiology of sports activities are being studied quite actively. Studies conducted in this field, demonstrate conflicting results, which, however, provide an understanding that the immune response to sports depends on the physical exercise intensity. The high intensity training process in athletes leads to a decrease in immunity, which can cause the development of various pathological processes (Vasilenko: 2010). Moderate exercises either do not affect the immune system performance, or stimulate it, which generally leads to a decrease in inflammatory responses in individuals involved in sports activities (Carlson et al.: 2017, pp.1236-1240). Such a pattern allowed for recommendations to determine the immune status as an assessment test for athletes overtraining (Meaney et al.: 2016).

The works dedicated to the immune response to sports activities in the northern regions are scarce. Thus, it is shown that the immune status of athletes living and training in KMAO-Yugra is higher in males than in females, while it decreases significantly in both genders in winter and spring time. However, these changes do not show statistically significant alterations from the peers, residents of the region, who are not involved in sports activities (Zaitseva: 2012, pp.89-91). The picture presented proves that the study of the immune status of individuals involved in sports activities in the northern regions is a quite relevant and promising topic.

Hormonal system and metabolism. Hormonal regulation features and metabolism changes in sports activities in the northern region are not studied well enough. Thus, we have come across isolated studies showing that the main differences in individuals involved in sports activities and living in KMAO-Yugra are significantly due to seasonal variations in hormone levels, in contrast to those not involved in sports activities. For "pituitary-adrenal" and "pituitary-gonad" systems, increased activity is observed during the maximum duration of daylight, and increased functional activity in the "pituitary-thyroid" system is observed during a short daylight (Zhemanov: 2017, pp.40-41).

Decreased leptin, testosterone and blood lipids during sports activities in the northern regions were evident, in turn, the growth hormone dynamics did depend on the kind of sport (Hackney&Aggon: 2018).

Undoubtedly, this data is not enough to form even a rough idea of the body hormonal response features in individuals involved in sports activities and living in the northern regions, as opposed to those individuals not involved in sports activities.

Musculoskeletal system. If there are data on muscle mass changes in individuals involved in sports activities and living in KMAO-Yugra, and these data clearly evidence muscle mass growth relative to the peers not involved in sports activities (shown above), then specific changes in bone tissue and its mineralization within this cohort are scarcely studied. Although, to date, there are numerous data showing that sports activities contribute to increased bone mineral density, reducing the occurrence of osteopenia and osteoporosis, especially in adolescents and young females (Stogov et al.: 2016, pp.198-200).

In this direction, there are also interesting observations showing that vitamin D in individuals involved in sports activities in the northern regions, despite sufficient consumption, remained below the values in those residents living in moderate latitudes (Jerome et al.: 2017).

It also shows that different sports can have different effectiveness in terms of increasing bone mass (Silva et al.: 2011, pp.227-234). In general, it is worth admitting that the features of changes in the skeletal system indicators in sports activities in the northern region require a scientific assessment and analysis.

There are works showing muscle metabolism features in sports activities at low temperatures: angiogenesis increases, glycogen recovery rate increases, with genetic activity disorders being not observed (Zak et al.: 2017, pp.319-325). However, musculoskeletal injuries got in sports activities at low temperatures has increased considerably (Fudge et al.: 2015, pp.63-68).

Psyche. Works in this field are isolated. It states that sports activities among the region residents can generally stabilize their mental state due to additional emotional experiences and social self-affirmation. Also, it has been shown that affected by physical activity, pain perception decreases, and cognitive abilities increase, which instead, however, decrease during outdoor activities (Geneen et al.: 2017).

## DISCUSSION

The assessment of the available data and the opinion of most researchers unequivocally comes down to the fact that changes in functional systems of the body in individuals involved in sports activities and living in the northern regions are positive and aimed at increasing the body adaptability to the living conditions. With that, there is an opinion that the higher the personal physical fitness, the higher the compensatory mechanisms of their functional systems. Therefore, the body adaptation to environmental factors of the northern region proceeds faster (Baev et al.: 2007, pp.31-33). We find this opinion to be controversial.

In particular, the literature review we presented reveals that in the northern regions, there are vulnerable groups for whom sports activities (or particular sports) can lead to functional disorders (maladaptation) of particular body systems with a higher risk of pathology development. These data suggest that increased body fitness in the North does not always lead to increased resistance to living conditions.

Aggregate data on the main changes occurring in the body of those involved in sports activities in the northern region are summarized in the table, which also presents vulnerable groups and annual periods when adaptability disorder risks of a particular functional system are higher.

System of organs and/or physiological indicator	Positive effect	Vulnerable groups
Anthropometric indicators	BMI decrease, muscle growth	Children aged 7.
Cardiovascular system	Performance improvement	Females aged 10-11.
Respiratory system	Increased power and efficiency	Winter sports activities, school age.
Blood and hematopoiesis	No abnormalities	Sports activities in winter.
Immune system	No abnormalities	Sports activities in winter, females.
Hormonal system and metabolism	No abnormalities	Seasonal dependence.
Musculoskeletal system	No data	Females.
Psyche	Emotional background, social self-affirmation	No data.

**Table 1.** Changes occurring in the body of individuals involved in sports activities in the northern region

Note: The "Positive effect" column presents changes aimed at improving the adaptability of individuals involved in sports activities to the climatic and geographical conditions of the North. The "Vulnerable groups" column presents population groups or the year period when sports activities affect negatively the corresponding functional system.

In general, it is worth mentioning that almost all researchers note that the positive effect of sports activities (regardless of the sport) in residents of the northern regions is based on increased motion (physical) activity. However, taking into account the vulnerable groups, a measured out approach is needed to determine the modes of motion and physical activity, with mandatory additional biomedical monitoring over the functional states of particular body systems (Malkov et al.: 2014, pp.86-90). In addition, food support options are widely represented to mitigate risks of conversion of adaptive shifts into pre-pathological ones that are observed during sports activities in extreme conditions (Sureda et al.: 2014, pp.373-379).

Additional factors affecting the body systems functioning in individuals involved in sports activities in the northern regions. A number of researchers study the effect of some additional factors that determine specific changes in functional systems of the body in athletes living in the northern regions, which are not observed in athletes living in other latitudes.

Thus, a group of authors distinguishes an adaptation issue in the northern athletes when for competition purposes they move from the region of residence to another one, usually in southern and moderate latitudes (Povzun et al.: 2018, pp.86-88). It states that moving from north to south, northern athletes experience greater exertion than those of temperate and southern latitudes when moving backwards (Apokin et al.: 2014, pp.87-90).

Cross-adaptation effects are a separate field of study. Thus, it has been established that cold adaptation improves altitude adaptation, and individuals involved in physical training and sports activities, unlike those not involved in physical training and sports activities, are more adapted to reverse changes in climatic living conditions (migration from north to south) (Gibson et al.: 2017, pp.1751-1768).

Also, it notes that significant seasonal variations in functional systems indicators of the body (CCC, hematological and immunological indicators), regarded as increased functional capabilities of the body for living in the northern region, lead to decreased athletic performance (specifically in spring) in those athletes from temperate and southern latitudes (Apokin et al.: 2015, pp.83-85). Indeed, it has been established that the factors mentioned above cause a decrease in athletic performance of athletes in KMAO-Yugra and lead to extended recovery period following the competition (Isaev et al.: 2010, pp.132-136).

Due to considerable differences in the functioning of particular body systems of athletes involved in sports activities in the northern regions, particular measures to improve the functional state of this cohort are currently being developed to support their sports qualities (Khismatullina et al.: 2013, pp.38-44). However, the efficiency of this technology is not evident yet and requires a substantial evidence base.

## **CONCLUSION**

The literature data presented in this section show unambiguously that sports activities among the KMAO-Yugra residents, especially young individuals (aged 18-25), contribute to improving their functional indicators of adaptation to the living conditions.

It is also evident that considering a climatic-geographic factor is necessary for choosing sports orientation in order to correct the state of particular functional systems, since existing physiological changes caused by environmental conditions affect the training process in various sports. In this process, a significant role belongs to the monitoring and biomedical diagnostics of disorders caused by training and sports activities in individuals involved in sports activities in the northern regions.

It should be noted that the analyzed literature data dedicated to the study of the specific changes in the functional systems of the body in individuals involved in sports activities and living in the northern regions showed a sufficient heterogeneity between the actual material and the depth of the scientific assessment. Thus, in this cohort, the functioning features of the cardiovascular and respiratory system have been studied quite well. Such an in-depth study allows for detecting vulnerable groups and performance indicators that show a failure of athletes' adaptation to physical exercises. In turn, functioning features of the immune,

hormonal and skeletal systems are basically unstudied. The importance of these systems for regular sports activities is evident, which shows the relevance and novelty of studying the body systems response to physical activity in individuals involved in sports activities in the northern regions.

Besides, the literature data review revealed a number of other understudied issues in the field of sports physiology in extreme living conditions. Consequently, the features of adaptation to physical exercises of individuals involved in sports activities, being migrant descendants in a series of generations, remain actually unstudied (Soloviev et al.: 2010).

## **BIBLIOGRAPHY**

APOKIN, VV, POVZUN, AA& POVZUN, VD (2015). "Fyntyne Seasonal variations in adaptation capabilities of the body in school students involved in sports activities."Teoria i praktika fizicheskoy kultury (Theory and Practice of Physical Education), 10(1), pp.83-85.

APOKIN, VV, POVZUN, AA, RODIONOV, VA& USAEVA, NR (2014). "Biorhythmological analysis of the body non-specific adaptability state in swimmers from different climatic-geographic regions."Teoria i praktika fizicheskoy kultury (Theory and Practice of Physical Education), 1(4), pp.87-90.

BAEV, KA, KLIMOV, OV& KHISAMOVA, AV (2007). "Indicators of functional systems of the body in Surgut State University students with different physical fitness levels."Vestnik novykh meditsynskikh tekhnologiy (Journal of New Medical Technologies), 14(1), pp.31-33.

BLINNIKOVA, AE, KOINOSOV, AP& BORISOV-FEDOSOV, MV (2013). "Study of the respiratory system indicators in children of the indigenous population of KMAO-Yugra with different motion modes."Nauchny meditsinsky vestnik Yugry (Scientific Medical Bulletin of Yugra), 2(4), pp.9-13.

BUSHEVA, ZI&AUSTER, AV (2012). "The study of physical development indicators of children aged 7 in sports activities in the North."Nauchny meditsinsky vestnik Yugry (Scientific Medical Bulletin of Yugra), 2(1), pp.44-46.

CARLSON, LA, LAWRENCE, MA, LECAVALIER, K& KOCH, AJ (2017). "Salivary lymphocyte responses following acute anaerobic exercise in a cool environment."J Strength Cond Res, 31(5), pp.1236-1240.

FILIPPOVA, EA (2016). "Features of anthropometric indicators in athletes specializing in Northern all-around."Problemy sovershenstvovaniya fizicheskoi kultury, sporta i olimpizma (Issues of Physical Education, Sports and Olympism Improvement), 1(9),pp.235-241.

FUDGE, JR, BENNETT, BL, SIMANIS, JP& ROBERTS, WO (2015). "Medical evaluation for exposure extremes: cold."Wilderness Environ Med, 26(4), pp.63-68.

GENEEN, LJ, MOORE, RA, CLARKE, C, MARTIN, D, COLVIN, LA& SMITH, BH (2017). Physical activity and exercise for chronic pain in adults: an overview of Cochrane Reviews.Cochrane Database Syst Rev.

GIBSON, OR, TAYLOR, L, WATT, PW& MAXWELL, NS (2017). "Cross-adaptation: heat and cold adaptation to improve physiological and cellular responses to hypoxia." *Sports Med*, 47(9), pp.1751-1768.

GOVORUKHINA, AA& NEZHINSKAYA, YA (2017). "The risk of cardiovascular system disorders development in acrobat females aged 10-11 in the North." *Vestnik Surgutskogo gosudarstvennogo universiteta (Surgut State University Journal)*, 4(18), pp.8-13.

GREEN, DJ&SMITH, KJ (2018). "Effects of Exercise on Vascular Function, Structure, and Health in Humans." *Cold Spring Harb Perspect Med*, 8(4).

GUBINA, AE& KOINOSOV, AP (2016). "The status of some immunity indicators and of general blood test in athletes of the city of Khanty-Mansiysk during the short daylight hours." *Vestnik Surgutskogo gosudarstvennogo universiteta (Surgut State University Journal)*, 3(13), pp.65-67.

HACKNEY, AC& AGGON, E (2018). "Chronic low testosterone levels in endurance trained men: the exercise-hypogonadal male condition." *J Biochem Physiol*, 1(1).

ISAEV, AP, BOBROVSKI, AV, ERLIKH, VV& NENASHEVA, VA (2010). "Multifunctional variability and mobility of homeostasis in Olympic Reserve athletes." *Vestnik Yuzhno-Uralskogo gosudarstvennogo universiteta (Bulletin of South Ural State University)*, 6(182), pp.132-136.

JEROME, SP, STICKA, KD, SCHNURR, TM, MANGUM, SJ, REYNOLDS, AJ& DUNLAP, KL (2017). "25(OH)D levels in trained versus sedentary university students at 64° north." *Int J Circumpolar Health*, 76(1).

KHISMATULLINA, IP, SOKOLOV, AG, FEDOSOV, YN, RUTKOVSKY, AV, AKSENOVA, IG& KIM, VN (2013). "Correction of endothelial dysfunction, neurovegetative status, blood biochemistry and performance in children and youth sports using api-phyto products." *Sibirskiy meditsynskiy zhurnal (Siberian Medical Journal)*, 28(1), pp.38-44.

KIPPELEN, P, ANDERSON, SD& HALLSTRAND, TS (2018). "Mechanisms and biomarkers of exercise-induced bronchoconstriction." *Immunol Allergy Clin North Am*, 38(2), pp.165-182.

KOINOSOV, AP (2008). Morphotypological aspects of the cardiorespiratory system of children in sports activities in the North. *Morfologicheskie vedomosti (Morphological Newsletter)*.

KOINOSOV, AP, KURENKOVA, DI& BLINNIKOVA, AE (2014). "Individual morphofunctional features in young males performing different motion modes." *Nauchny meditsinsky vestnik Yugry (Scientific Medical Bulletin of Yugra)*, 2(5), pp.88-91.

KOINOSOV, PG, CHIRYATIEVA, TV, KOINOSOV, AP, ORLOV, SA, IONINA, EV, ZHVAVY, PN, KOLOMYS, VE& KURENKOVA, ID (2016). "Physical development of children of indigenous peoples of the North with different motion activity mode." *Meditsinskaya nauka i obrazovanie Urala (Medical Science and Education of the Urals)*, 2(86), pp.62-65.

KRALOVA, LI., RYCHLIKOVA, J, VAVROVA, L& VYBIRAL, S (2015). "Could human cold adaptation decrease the risk of cardiovascular disease?" *J Therm Biol*, 52(5), pp.192-198.



KUCHIN, RV& Stogov, MV (2019). "Features of physiological processes in migrants and indigenous population of Ugra (Russia)."Utopia y Praxis Latinoamericana, 24(5),pp.72-78.

MALKOV, MN, BULGAKOVA, OV, APOKIN, VV& LOGINOV, SI (2014). "The effect of regular exercise on the health status and physical fitness of adult males and females in the Yugra North."Teoria i praktika fizicheskoy kultury (Theory and Practice of Physical Education), 8(3), pp.86-90.

MANOU-STATHOPOULOU, V, GOODWIN, CD, PATTERSON, T, REDWOOD, SR, MARBER, MS& WILLIAMS, RP (2015). "The effects of cold and exercise on the cardiovascular system."Heart, 101(10), pp.808-820.

MEANEY, MP, NIEMAN, DC, HENSON, DA, JIANG, Q& WANG, FZ (2016). Measuring granulocyte and monocyte phagocytosis and oxidative burst activity in human blood.J Vis Exp.

NIKITINA, LY, PETROVSKY, FI& SOODAEVA, SK (2014). "Ergospirometry parameters of physical exercise bronchial spasm, the relation of cardiorespiratory testing indicators with NO fraction in exhaled air in skiers and biathletes."Fundamentalnie issledovania (Fundamental Research), pp.1540-1545.

POGONYSHEVA, IA, POGONYSHEV, DA& SOLOVIEV, VS (2015). "Heart bioelectric activity of athletes in the conditions of the Ob River North."Vestnik Tyumenskogo gosudarstvennogo universiteta (Tyumen State University Herald), Natural Resource Use and Ecology, 1(3), pp.218-224.

POVZUN, AA, POVZUN, VD, APOKIN, VV& USAEVA, NR (2018). "Rhythmological assessment of gender urgent adaptation features in junior athletes with latitudinal movement."Teoria i praktika fizicheskoy kultury (Theory and Practice of Physical Education), 3(3), pp.86-88.

RUTKOVSKIY, AV, KOINOSOV, AP& DUDKO, AV (2018). "Seasonal dynamics of red blood and physical performance indicators in cyclic winter athletes in the climatic conditions of the Middle Ob region."Meditsinskaya nauka i obrazovanie Urala (Medical Science and Education of the Urals), 2(94), pp.48-52.

SASHENKOV, SL, PYLAEVA, IL, KOLUPAEV, VA& DOLGUSHIN, II (2012). "The environmental effect on cellular and humoral immunity in athletes."Gigiena i sanitaria (Hygiene and Sanitation), 42(4).

SILVA, CC, GOLDBERG, TB, TEIXEIRA, AS& DALMAS, JC (2011). "The impact of different types of physical activity on total and regional bone mineral density in young Brazilian athletes."J Sports Sci, 29(3), pp.227-234.

SOLOVIEV, VS, ELIFANOV, AV, SOLOVIEVA, SV& PANIN, SV (2010). Age-related dynamics of adaptive properties of the 1st and 2nd generations of new settlers in the Middle Ob region.

STOGOV, MV, CHERNITSYNA, NV& KUCHIN,RV (2016). "The effect of sports on bone mineral density in female descendants of migrants in KMAO-Yugra."Vestnik Yugorskogo gosudarstvennogo universiteta (Bulletin of Yugra State University), 1(40), pp.198-200.

SUREDA, A, TEJADA, S, BIBILONI, MM, TUR, JA& PONS, A (2014). "Polyphenols: well beyond the antioxidant capacity: polyphenol supplementation and exercise-induced oxidative stress and inflammation."Curr Pharm Biotechnol, 15(4), pp.373-379.

VAN DER VORM, LN, HUSKENS, D, KICKEN, CH, REMIYN, JA, ROEST, M, DE LAAT, B& MISZTA, A (2018). "Effects of repeated bouts of exercise on the hemostatic system." *Semin Thromb Hemost*, 44(8), pp.710-722.

VASILENKO, VS (2010). The role of the immunity B-system in stress cardiomyopathy pathogenesis in athletes. *Vestnik Sankt-Petersburgskogo universiteta (Vestnik of Saint Petersburg University)*.

ZAITSEVA, IP (2012). "The state of the phagocytic link of the immune system in student athletes, depending on the trained level, gender and year season." *Mezhdunarodnyi zhurnal prikladnykh i fundamentalnykh issledovaniy (International Journal of Applied and Fundamental Research)*, 2(4), pp.89-91.

ZAK, RB, SHUTE, RJ, HEESCH, MW, LA SALLE, DT, BUBAK, MP, DINAN, NE, LAURSEN, TL& SLIVKA, DR (2017). "Impact of hot and cold exposure on human skeletal muscle gene expression." *Appl Physiol Nutr Metab*, 42(3), pp.319-325.

ZHEMANOI, MF (2017). "Seasonal variations in thyroid system indicators in athletes training in the Middle Ob region." *Nauchny meditsinsky vestnik Yugry (Scientific Medical Bulletin of Yugra)*, 1(11), pp.40-41.

## **BIODATA**

**KUCHIN ROMAN VIKTOROVICH:** Candidate of Biological Sciences, Assistant Professor, Institute of Humanities, North Caucasus, Gogorsk State University. Areas of scientific interest: sport physiology and adaptations to physical stress, muscle and bone biochemistry, methodology of sciences