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# IDENTIFICATION OF A GROUP FOR RESEARCH OF TELOMERIC AGING

I. M. Spivak (a)*, T. Y. Smirnova (b), P. A. Slizhov (c), D. L. Spivak (d)
*Corresponding author

(a) Military Medical Academy, ul. akad. Lebedeva, 6B, St. Petersburg, 194044, Russia, St. Petersburg State University, Universitetskaya nab., 7/9, St. Petersburg, 199034, Russia, irina_spivak@hotmail.com
(b) Pokrovslki bank of stem cells, Bolshoi pr., B.A., 85K, St. Petersburg 199106 Russia, tatiana.smirnova@live.ru,
(c) Military Medical Academy, ul. akad. Lebedeva, 6B, St. Petersburg, 194044, Russia, The Herzen State Pedagogical University of Russia, 48, Moika Emb., St. Petersburg, Russia, 191186, maidel@bk.ru,
(d) D.S.Likhachev Russian Institute of Cultural and Natural Heritage, Bersenevskaya nab., 18-20-22, Moscow, 119072, Russia; Human Brain Institute, Russian Academy of Sciences, ul. akad. Pavlova, 9, St.Petersburg, 197376, Russia, d.spivak@mail.ru

## *Abstract*

As part of research project aimed at systematic study of relationship between creativity and longevity, study of molecular-biological aspect longevity was undertaken. Telomeres shortening is associated with the cellular and organismic aging. Telomere length is determined by genetic factors and also formed by non-genetic effects throughout a person's life in a cumulative way. This idea is confirmed by data on longer telomeres in long-livers. Longevity is also associated with cognitive functions and creativity. In order to identify connection between creativity and telomere length at initial stage, a study was conducted in search of groups of people with longer telomeres in a population, the first of which was identified as professional athletes consisting of 49 subjects of both sexes aged 13 to 53 years. Control group consisted of 163 respondents without pathology in anamnesis. It was found that mean telomere length of athletes was significantly longer than that of ordinary respondents. Thus, the telomere length tends to follow several basic strategies. If the initial telomeres are short, respondents do not engage in activities that require particular endurance and creativity. If initially they are long, then people are engaged in such kinds of activities, as we have shown on the example of athletes. Thus, inheritance; early training; emotional arousal tend to serve as the basic factors of telomere length by people of this kind. Starting from this point, basic groups of high achievement groups, medium and low achievement groups should serve as the primary objects for analysis in studying creativity and longevity.



**Keywords:** Athletes, creativity, longevity, population studies, telomere length.

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## 1. Introduction

Terminal sections of eukaryotic chromosomes - telomeres - form one of the most actual factors determining life expectancy (Blackburn et al., 2015). Interest in these specialized complexes is determined by unique functions performed by them, maintaining the integrity of the cell genome (Bhargava et al., 2020). Representing special terminal sections of chromosomes, telomeres protect the genome from damage. However, DNA is shortened in the region of telomeric repeats with each division of the cell, which limits proliferative potential of cells and, obviously, serves as a "counter" of the number of divisions - and, correspondingly, cell life. Individual length can depend either on the hereditary characteristics of the body (there is a number of mutations of genes leading to accelerated aging) or cancer (Srinivas et al., 2020), or on the influence of lifestyle. Combined effect of a wide variety of stress factors on the length of telomeres is now one of the topics widely discussed in the scientific literature (Cabeza de Baca et al., 2019; Puterman et al., 2010). At the same time, not only the negative effect of stress on the telomere length was shown, but also the possibility of maintaining their length – or, even, in some cases, their elongation (Spivak et al., 2018). The search for active longevity reveals presence of correlation of telomere length with various physiological and psychological characteristics. Long-livers tend to have longer telomeres, they are creative and demonstrate preservation of basic cognitive functions (Gutman et al., 2020). Connection of longevity with cognitive functions and creativity was shown in quite a few studies (Colombo et al., 2018; Fancourt & Steptoe, 2018; Joung & Lee, 2019). Attempts are constantly being made to influence the length of telomeres, slowing down the process of their shortening. We have traced back positive and negative effect of music of different kinds upon both telomere length and telomerase activity (Spivak et al., 2018). It was also shown that any stimuli - physical practices, yoga, meditation - have a much stronger positive effect on the condition of people who regularly engage in physical exercises, including telomere length and telomerase activity (Epel et al., 2016; Tai et al., 2018).

## 2. Problem Statement

Achievement of active longevity is accompanied by preservation of cognitive functions and stabilization of telomere length. Since telomeres are one of the leading markers of general state of health, it is important to identify groups of people with longer telomeres in the population, and assess their reasons.

## 3. Research Questions

When comparing population samples, we singled out athletes who had achieved high results. Significant shortening of telomeres under the influence of oxidative stress in some athletes after a 2.5-hour run was described previously (Dufaux et al., 1997), while systematic physical activity of professional athletes, based on measured stress levels, can lead to activation of telomerase in the chromosomes, and to stabilization of telomere length (Kadi et al., 2008). Professional runners of various age groups showed an increased level of telomere stabilizing proteins, decreased content of leukocyte apoptosis regulators, increased telomere length and telomerase activity (Rae et al., 2010). At the same time, it was shown that rather high level of creativity belongs to the set of basic qualities of a

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professional athlete (Kruyt & Grobbelaar, 2019), which forms a preliminary theoretical ground for us to study active longevity, basing not only upon general population, but on particular groups, such as athletes. The main research question of this study is whether mean telomere length in athletes differ from average telomere length in a population.

## 4. Purpose of the Study

Due to numerous discrepancies in the existing literature data, we decided to conduct our own study of telomere length in a group of trained athletes with high level of endurance, and to determine whether the speed of shortening of telomeres of chromosomes depends on the presence of regular physical activity.

## 5. Research Methods

Telomere lengths in peripheral blood leukocytes were measured in a population of healthy donors of the North-West of the Russian Federation and in a group of athletes, consisting of 49 professional long-distance runners. The group included respondents of both sexes aged 13 to 53 years. Control group consisted of 163 practically healthy subjects, aged from 2 to 87 years **without pathology in anamnesis**, belonging to general population of the aforementioned region.

Measurement of telomeres was carried out by two methods:

Flow-FISH method, using special probes, i.e. peptide-nucleic acids, complementary to the repeating telomeric sequence associated with fluorescent dye FITC. Simultaneous DNA staining allows only cells that are at the G0 / G1 stage to be selected for analysis. As an internal control, a standard T-lymphoblastoid leukemia cell line 1301 was used, characterized by stable telomere length, regardless of passage.

Real-time polymerase chain reaction was applied, using our modification of the original protocol (Vasilishina et al., 2019), which conditioned the use of specific primers that did not form dimers when conducting qPCR, which is achieved due to their incomplete complementarity with telomeric repeats:

Tel-1: 5'-GGTTTTTGA GGGTGAGGGTGAGGGTGAGGGTGAGGG T-3 '; Tel-2: 5'-TCCCGACTA TCCCTATCCCTATCCCTATCCCTATCCCTA-3 '.

Average telomere length in the sample (in kbp) was calculated according to an original method (Vasilishina et al., 2019), using calibrator dilutions of 84-membered synthetic oligonucleotide, consisting of telomeric repeats TTAGGG. Average telomere length per genome was calculated by normalizing the number of copies of telomeric repeats to that of the PO 36B4 (T / S) ribosomal phosphoprotein gene, localized at chromosome 12, and presented as a single copy in the cell. The following primers were used for amplification of ribosomal phosphoprotein gene: 36B4u: 5'-CAGCAAGTGGGAAGGTGTAATCC-3 '; 36B4d: 5'-CCCATTCTATCATCAACGGGTACAA-3 '.

## 6. Findings

Telomere length of athletes turned out to be significantly higher than that of ordinary respondents of the same age. Average length of telomeres in the former group was 9.5 kbp, while that in the control

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group was 7.02 kbp (t=6.8, p≤0.01). This result can be explained by the fact that people, born with longer telomeres, tend achieve higher results – in sports, in the case of our study. These results are presented at Figure 1.

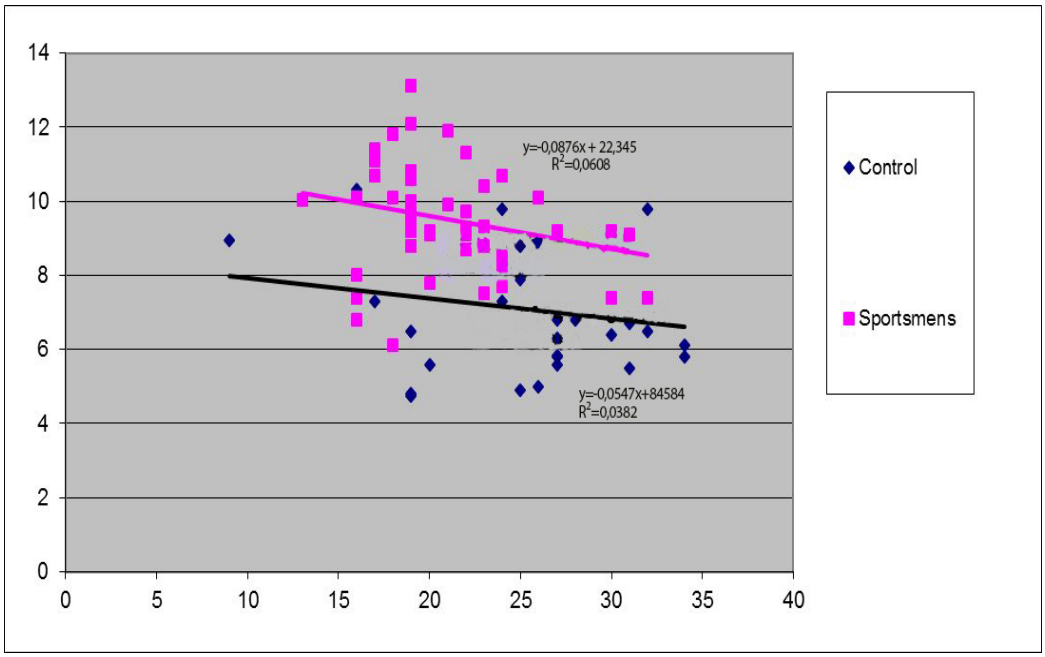


**Figure 01.** Average telomeres length in peripheral blood lymphocytes, in the groups of professional athletes (main group), and in general population (control group)

## 7. Conclusion

Data acquired by us, are supported by a number of works where athletes with high achievements were shown to have longer telomeres (Muniesa et al., 2017; Simoes et al., 2017), although there has never occurred up till now any serious discussion of the causes of this regularity. The first assumption is the simplest one - people born with longer telomeres, tend to start training early, and achieve finally high athletic results. Longer telomeres were observed in long-livers aged 100 or more, and their relatives (Gutman et al., 2020). But in these groups of centenarians, professional athletes were practically not present. Of course, people who achieve considerable results in sports, tend have most positive motivation, which helps to maintain telomere length (Muniesa et al., 2017; Simoes et al., 2017), but at the same time, they show strong features of psychological and nervous tension, and even at times some features of depressive disorders (Kim et al., 2020). Since they begin to train in childhood and adolescence (Kwon, 2018), when the influence of any effects on the telomere length is most pronounced, both positive and negative (Bersani et al., 2016; Henje Blom et al., 2015), we might assume that the corresponding telomere status is established roughly at that time. Therefore, all the positive things that sport brings to life, like education opportunity, career success, etc., affect telomere length quite strongly, especially when supported by personal qualities necessary for the athlete (Vaughan et al., 2019). At the same time, increase in telomere length was shown in people coping with life stress, which was considered as a protective reaction leading to an increase in telomerase activity, and elongation of telomere length, as a result (Spivak et al., 2018). If the negative effect was short, then the adaptive increase in telomerase

activity did not lead to lengthening of the telomeres, but rather to their shortening or, their maintenance at the same level (Spivak et al., 2018). Probably, all these reasons – heredity, creativity, and positive reinforcement in childhood, mastering adaptation to long-term physical and psychological stresses, contribute to significantly longer telomere length in professional athletes. Shortening of telomere length, described by some authors in the case of athletes of high level, can be a short-term phenomenon, e.g. cf. Puhlmann et al., (2019) after Mental Training. The results obtained support the idea that sports competences - and, in a more general sense, creative skills - can be regarded as properties necessary for the development of human potential, where connection between creativity and longevity may be supposed.

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