

DOI 10.54596/2958-0048-2026-3-58-66

UDC 574/577

IRSTI 34.39.51

THE IMPORTANCE OF BIOLOGICAL AGE IN ASSESSING THE HEALTH LEVEL OF UNIVERSITY TEACHERS

E. Kabdolla^{1*}, A.B. Myrzabayev¹, G.T. Tnimova², M.T. Bodeyev¹, N.I. Sabanbayev¹

^{1*}*Karaganda National Research University named after E.A. Buketov,
Karaganda, Kazakhstan*

²*«Bolashaq» Academy, Karaganda, Kazakhstan*

**Corresponding author: kab-1990@mail.ru*

Abstract

The article presents the results of a study on the health status of university teachers. The research included an anonymous survey and an analysis of physiological indicators. A total of 186 individuals participated in the study, of whom 127 were affiliated with the Karaganda Buketov University and 59 with Altai State University. Data collection was carried out during the transition to distance learning amid the COVID-19 pandemic, as well as after its completion. Biological age was evaluated through a comprehensive analysis of body weight, blood pressure, static balance, and subjective self-assessment of health. The calculated individual scores were further interpreted by comparing them with appropriate age standards. It was found that in 22.58% of the examined teachers the aging process was slowed down, in 25% it corresponded to the population norm, whereas in 52.1% accelerated aging was observed. In addition, inter-university differences in the characteristics of aging rates among teachers were identified. Among teachers of the Karaganda Buketov University, the proportion of individuals with an accelerated aging process was 55.9%, whereas among those from Altai State University this indicator was lower, amounting to 44%. The observed differences may be explained by the fact that at Buketov University the study was conducted during the pandemic period. Given that hormonal mechanisms exert different effects on male and female organisms, the rates of aging may also differ substantially. In particular, among male teachers of Buketov University, 79.37% were classified as being in the risk group, while among women this figure was 32.78%. At Altai State University, the corresponding proportions for men and women were 66.67% and 31.58%, respectively. The findings indicate that the pandemic had a significant impact on the health status of university teachers. Morphofunctional differences between male and female organisms may also contribute to these outcomes.

Keywords: physical health, stress, age, biological age, teachers, gender differences.

ЖОҒАРЫ ОҚУ ОРНЫ ОҚЫТУШЫЛАРЫНЫҢ ДЕНСАУЛЫҚ ДЕҢГЕЙІН АНЫҚТАУДАҒЫ БИОЛОГИЯЛЫҚ ЖАСТЫҢ МАҢЫЗЫ

Кабдолла Е.^{1*}, Мырзабаев А.Б.¹, Тнимова Г.Т.², Бөдеев М.Т.¹, Сабанбаев Н.И.¹

^{1*}*Е.А. Бөкетов атындағы Қарағанды ұлттық зерттеу университеті,
Қарағанды, Қазақстан*

²*«Bolashaq» Академиясы, Қарағанды, Қазақстан*

**Хат-хабар үшін автор: kab-1990@mail.ru*

Аңдатпа

Мақалада ЖОО оқытушыларының денсаулық деңгейлері зерттелеген. Зерттеу жұмыстарында оқытушылардан анонимді сауалнама алынды және олардың физиологиялық көрсеткіштері зерделенді. Зерттеуге 186 оқытушы қатысты. Олардың 127-сі Е.А. Бөкетов атындағы Қарағанды ұлттық зерттеу университетінің оқытушылары, ал 59-ы Алтай мемлекеттік университетінен. Зерттеу жұмыстары қашықтықтан оқуға көшкен пандемия кезінде (Covid-19) және пандемия аяқталған соң жүргізілді. Оқытушылардың биологиялық жастарын есептеп шығару үшін дене салмағы, артериялық қысым, статикалық теп-теңдік пен оқытушының өз денсаулығын бағалау жүйесі қолданылды. Нәтижесінде

университет оқытушыларының биологиялық жастарының дербес көрсеткіштері мен болуы керек жас дәрежесі анықталды. Зерттелген оқытушылардың 22,58% қартаю процесі баяу жүріп жатқан болса, 25,27% нормаға сәйкес, ал 52,1% қартаю процесі қарқынды өтуде. Сонымен қатар, екі университет оқытушыларының қартаю процесінде айырмашылық байқалды. Бөкетов университеті оқытушыларында қартаю процесі 55,9% құраса, Алтай университетінің оқытушыларындағы бұл көрсеткіш 44% болды және оған Бөкетов университетіндегі зерттеу жұмыстарының пандемия кезінде жүргізілгені әсер етті деуге болады. Гормандар еркектер мен әйелдердің ағзаларына әртүрлі әсер ететіндіктен, олардың ағзаларындағы қартаю процесі де әртүрлі болады. Мысалы, Бөкетов университеті ер оқытушыларының тәуекел тобына жататындар 79,37% болса, әйелдерде 32,78% болды. Алтай университетінің ер оқытушыларында бұл көрсеткіштер тиісінше 66,67% және 31,58% құрады. Зерттеу жұмыстары көрсеткендей, оқытушылардың денсаулықтарына пандемия айтарлықтай әсер етеді. Оған еркектер мен әйелдердің ағзаларындағы морфологиялық-функционалдық айырмашылықтар да себеп бола алады.

Кілт сөздер: денсаулық, стресс, жас мөлшері, биологиялық жас, оқытушылар, гендерлік айырмашылық.

ЗНАЧЕНИЕ БИОЛОГИЧЕСКОГО ВОЗРАСТА В ОПРЕДЕЛЕНИИ УРОВНЯ ЗДОРОВЬЯ ПРЕПОДАВАТЕЛЕЙ ВЫСШИХ УЧЕБНЫХ ЗАВЕДЕНИЙ

Кабдолла Е.^{1*}, Мырзабаев А.Б.¹, Тнимова Г.Т.², Бодеев М.Т.¹, Сабанбаев Н.И.¹

^{1*}*Карагандинский национальный исследовательский университет им. Е.А. Букетова,
Караганда, Казахстан*

²*Академия «Bolashaq», Караганда, Казахстан*

**Автор для корреспонденции: kab-1990@mail.ru*

Аннотация

В статье представлены результаты исследования уровня здоровья преподавателей высших учебных заведений. В рамках работы проведено анонимное анкетирование и анализ физиологических показателей. В исследовании приняли участие 186 человек, из которых 127 являлись преподавателями Карагандинского национального исследовательского университета имени академика Е.А. Букетова, 59 – Алтайский государственный университет. Сбор данных осуществлялся в период перехода на дистанционный формат обучения во время пандемии COVID-19, а также после её завершения. Расчёт биологического возраста выполнялся на основе показателей массы тела, артериального давления, статического равновесия и субъективной самооценки состояния здоровья. В результате были определены индивидуальные значения биологического возраста и проведено их сопоставление с должными возрастными нормативами. Установлено, что у 22,58% обследованных процесс старения протекает замедленно, у 25% соответствует популяционной норме, тогда как у 52,1% выявлено ускоренное старение. Дополнительно обнаружены межвузовские различия в характеристиках темпов старения преподавателей. У преподавателей Карагандинского национального исследовательского университета имени академика Е.А. Букетова доля лиц с ускоренным процессом старения составила 55,9%, тогда как у преподавателей Алтайский государственный университет данный показатель был ниже – 44%. Предположительно, на выявленные различия могло повлиять то обстоятельство, что в университете Букетова исследования проводились в период пандемии. Учитывая, что гормональные механизмы оказывают различное влияние на мужской и женский организм, темпы старения также могут существенно различаться. Так, среди мужчин-преподавателей университета Букетова к группе риска были отнесены 79,37%, тогда как среди женщин этот показатель составил 32,78%. У преподавателей Алтайского университета аналогичные показатели у мужчин и женщин составили соответственно 66,67% и 31,58%. Результаты исследования свидетельствуют о том, что пандемия оказала значимое влияние на состояние здоровья преподавателей. Определённую роль в этом могут играть и морфофункциональные различия мужского и женского организма.

Ключевые слова: физическое здоровье, стресс, возраст, биологический возраст, преподаватели, гендерные различия.

Introduction

Human ageing is a universal and regular process characterized by gradualness, irregularity and steady progression, inevitably affecting to a greater or lesser extent all levels of biological organization. The lifespan of a human being and its health condition are closely related to the essence of the ageing process of the organism.

A biological aging process is a change in living systems over a certain period of time, resulting in disturbances of their structure and function, which leads to a decrease in the reserve capacity of most systems of the human organism. In addition, it is accompanied by the formation of diseases associated with the aging process and an increase in mortality rates. [1, 2]. The ageing process is associated with continuous losses in muscle mass, qualitative composition and strength capacity. [3, 4]. In addition, there is the concept of biological age (BA). [5] Biological age is the age of a person's body, not the number of years lived. People themselves are interested in knowing their true age. For this purpose, it is necessary to determine the biological age of a person.

According to experts from the World Health Organization (WHO), the assessment of BA indicators represents an important diagnostic method that makes it possible to determine the rate of aging of an individual and their physical health, taking into account the effects of occupational activity and lifestyle [6, 7, 8].

Meanwhile, the formation of modern higher education, oriented on entering the world educational space, multifaceted transformations in pedagogical practice are accompanied by a radical breakdown of stereotypes in the consciousness, activity and lifestyle of subjects of higher professional education. In connection with the above, the health problem of university teachers is of particular relevance. Health is one of the conditions for effective professional activity of a modern person and is the main, relatively non-specific basis for the productivity of all aspects of labour and general well-being of a person [9, 10, 11]. In this regard, the purpose of this study is to assess the state of physical health of university teachers using an integral method - the method of determining their biological age.

Material and methods of research

The present study is a logical continuation of the authors' long-term investigation of the integral health indicators of university teachers in the Republic, aimed at conducting a comparative analysis of the prenosological health status of participants in the educational process during the period 2012–2026. The unexpectedly declared COVID-19 pandemic significantly altered the measured parameters, and these changes persisted even in the post-pandemic period. The assessment of these transformations and their impact on health indicators constitutes the focus of the present article.

The experiment involved 186 teachers, including 127 people (64 women, 63 men) from Karaganda University and 59 people (21 men and 38 women) from Altai State University. Biological age (BA) was calculated during the period of urgent transition of higher education institutions to distance learning due to the pandemic (Karaganda University) and after its termination during the transition of higher education institutions to the traditional mode of education (Altai State University). The study was conducted at the end of the first semester, during November–December. Physiological health indicators and self-rated health assessed using a standard questionnaire were evaluated and used to determine biological age (BA). The study included apparently healthy teachers who continued to carry out their professional activities. Furthermore, it should be emphasized that the baseline characteristics of the two universities were not identical. Consequently, the findings should be interpreted as reflecting a trend rather than providing definitive evidence of causal relationships or direct comparisons.

To determine the biological age of teachers, we chose the express method of V.P. Voitenko [12]. The choice of this method was justified by the intention to achieve a balance between measurement accuracy and ease of application without the use of expensive laboratory equipment. The main arguments supporting the selection of this methodology include its accessibility and non-invasiveness, consideration of the multifactorial nature of aging, suitability for comparative analysis, and prognostic value. Thus, this method represents a rapid, cost-effective, and comprehensive screening approach for assessing health status and determining the extent to which an individual's lifestyle corresponds to their chronological age.

The logical scheme for estimating BA includes the following stages: calculation of the BA value for a given individual (mathematical formula using a number of physiological indicators and self-assessment of health on a special questionnaire); calculation of the proper value of biological age (PBA) for a given individual; comparison of the obtained (BA) and the proper value (PBA): how many years the subject is ahead or behind his peers in terms of ageing. The obtained value is relative: the point of reference is the population standard - the average value of the degree of ageing (PBA) at a given calendar age (CA) for a given population. This approach allows to rank persons of the same CA by the degree of "age deterioration" and, consequently, by the "stock" of health (I and II ranks - slow ageing, III - BA corresponds to the population standard, IV and V - accelerated ageing).

To calculate BA in this variant we determined: body weight (kg), blood pressure (SBP, DBP and calculated pulse pressure (PP)), inspiratory breath hold (sec), static balancing (SB, sec), and also revealed self-assessment of health using a structures questionnaire (SAH, c.u.). To calculate biological age (BA), the following formulas were used and incorporated into a specially developed computer program (Terentenko A., 2004).

For men:

$$BA=27.0+0.22\cdot SBP-0.15\cdot BHT+0.72\cdot SHS-0.15\cdot SB$$

For women:

$$BA=1.46+0.42\cdot DBP+0.25\cdot BW+0.70\cdot SHS-0.14\cdot SB$$

The assessment of biological age (BA) was performed through a sequential analytical procedure. Initially, individual BA values were obtained for each participant using the previously described equations, followed by their standardization. To evaluate whether the observed level of biological aging corresponded to the participant's chronological age (CA), the calculated BA was compared with the proper biological age (PBA), which represents the population-based reference level of age-related changes. The ratio between BA and PBA (BA/PBA) was used to characterize the relative rate of aging, indicating whether the participant's biological age was above or below the average value expected for individuals of the same age group. In addition, the difference between BA and PBA (BA – PBA) was determined to quantify the extent to which the participant's aging process exceeded or lagged behind the population norm, expressed in years.

The proper biological age (PBA) was calculated using the following formulas:

For men: $PBA=0.629\cdot CA+18.6$

For women: $PBA=0.581\cdot CA+17.3$

Upon completion of the instrumental assessment, all collected measurements were systematically entered into a computerized database. Subsequently, the participating teachers completed a self-assessment questionnaire designed to evaluate their perceived health status.

The questionnaire consisted of 27 standardized items addressing various aspects of health and well-being. In addition, respondents were asked to provide an overall evaluation of their

health by selecting one of four categories: good, satisfactory, poor, or very poor. The questionnaire data were then integrated into the electronic database for further analysis. Based on the combined instrumental and survey data, individual biological age indicators and the level of aging progression were determined for each participant.

The research protocol adhered to internationally recognized ethical principles governing biomedical research involving human participants, including the provisions of the Declaration of Helsinki. Participation in the study was entirely voluntary, and all respondents provided written informed consent authorizing the collection, processing, and scientific use of the obtained information.

Results of the research

The measurements of the basic physiological indicators required for the calculation of biological age (BA) are presented in Table 1. To compare the obtained data, we used a similar study conducted by the authors during the period of traditional university education.

As shown in the table, among male teachers of Karaganda Buketov University (distance learning period), the mean systolic blood pressure (SBP) was 139.4 ± 5.3 mmHg, which was 9.7% higher than in the control group and exceeded normal reference values. At the same time, the diastolic blood pressure (DBP) was 83.8 ± 3.24 mmHg, which was 8.8% higher than in the control group (Table 1). The corresponding average values among teachers of Altai State University (transition to traditional education after the pandemic) were slightly lower: 132.5 ± 3.4 mmHg and 77 ± 2.4 mmHg, respectively.

The mean SBP and DBP values in women were lower than those observed in men across all study groups; however, the highest values among women were also recorded in the group of teachers from Karaganda University.

Table 1. Functional indicators of various body systems and self-rated health (SRH) among teachers during the emergency transition to distance learning and in the post-pandemic period, compared with the control group (PPI)

Functional indicators of various body systems	KarU during the pandemic		AltSU after the pandemic	
	men	women	men	women
SBP mmHg	$139,4 \pm 5,3$	$127,3 \pm 4,6$	$132,5 \pm 3,4$	$125,9 \pm 4,4$
DBP mmHg	$83,8 \pm 3,2$	$77 \pm 2,6$	$77 \pm 2,4$	$75,5 \pm 2,4$
BS (men)	$35,1 \pm 3,4$	-	$38,0 \pm 4,9$	-
SB sec	$11,6 \pm 2,1$	$9,1 \pm 1,6$	$11,5 \pm 3,1$	$7,9 \pm 1,9$
SAH	$8,0 \pm 2,6$	$11 \pm 1,1$	$6,5 \pm 1,1$	$9,3 \pm 1,3$
Note: the changes are significant compared to the M and W KarU data ($p < 0.05$)				

The inspiratory breath-holding time (BHT) measured in men demonstrated the following results. Among teachers of Karaganda Buketov University, the mean value was 35.1 ± 3.4 s, whereas among teachers of Altai State University it was 38.0 ± 4.9 s. In the control group, the corresponding value was 54.5 ± 9.11 s, which was 55.2% higher than that observed in the first group.

The most pronounced differences were identified in static balancing (SB), which reflects the functional state of the central nervous system, in both men and women. In male teachers of Karaganda University, SB was 11.6 ± 1.2 s, while among teachers of Altai State University it was also 11.6 ± 1.2 s. In the control group, this parameter reached 18.2 ± 3.4 s, which was 56.9% higher than among teachers of Karaganda University. Among women from Karaganda

University and Altai State University, SB values were 2–2.5 times lower than the corresponding control values.

The obtained self-rated health (SRH) scores demonstrated a slight tendency toward lower values among teachers of Karaganda University and Altai State University (Table 1). Thus, the findings indicate increased strain in the major physiological systems of teachers during the investigated period.

Assessment of the basic physiological indicators, analysis of the self-assessment of the health condition of university teachers, and calculation of individual figures of BA and PBA by the express method of V.P. Voitenko, enabled classification of the obtained results, as shown in Table 2. The average age of the participants was 47.38 ± 0.34 years. Biological age, in turn, reflects the degree of physiological wear and tear of the organism and in comparison with the calendar age testifies to the slowing down of the organism structure (I and II ranks), corresponds to the age population (III rank), or accelerated fasting of the organism (IV and V ranks).

Our calculations have shown (Table 2) that 22,58% of 186 surveyed teachers have slowed down ageing of the organism as compared to the population, a quarter of the surveyed teachers have ageing rates corresponding to those in the population, and the remaining 52,15% have accelerated ageing rates, i.e. are in a state borderline for health.

Further, we determined that there is a significant difference in the obtained ranking figures between the surveyed teachers of the two universities (Table 2). Thus, more than half (55.93%) of teachers at KarU were in the group with accelerated rate of ageing, and less than half (44.0%) of teachers at AltSU. It should be noted that our studies of teachers' BA before the pandemic and transition to the distance learning mode showed a much smaller group of accelerated ageing, this group comprised, on average, up to 20% of all those surveyed [13, 14, 15].

Table 2. Ranking of the BA indicator of teachers of the surveyed universities (%)

n-186	BA ranks (total)				
CA-47,38 ±0,34	I	II	III	IV	V
	8,06 (15)	14,52 (27)	25,27 (47)	22,58 (42)	29,57 (55)
n-127	BA ranks (KarU)				
CA-48,21 ±0,49	I	II	III	IV	V
	6,3 (8)	14,96 (19)	22,83 (29)	20,5 (26)	35,43 (45)
n-59	BA ranks (AltSU)				
CA-46,55 ±0.8	I	II	III	IV	V
	11,9 (7)	13,5 (8)	30,5 (18)	27,1 (16)	16,9 (10)

In connection with the above, there is no doubt that the urgent transition to the distance learning mode, as well as the exit from it, turned out to be a significant stressful load for university teachers, which affected the stressful functioning of the main physiological systems of the organism.

Since it is known that the functioning of male and female organisms differs significantly due to their different hormonal status and social roles, it was interesting to look at the ranking of BA in the gender aspect [16, 17, 18].

The numerical material obtained is reflected in Table 3. As can be seen from the table, out of all the surveyed KarU men, only 11.1% are in the group with delayed aging, about 10% are aging at the pace of the population, and the rest of the surveyed men fall into the risk group for healthy ageing (79.37%).

Table 3. Ranking of biological age of KarU teachers (%)

n-63	BA Men's Ranks				
	I	II	III	IV	V
	1,59 (1)	9,52 (6)	9,52 (6)	19,05 (12)	60,32 (38)
n-64	BA Women's Ranks				
	10,94 (7)	20,31 (13)	35,94 (23)	21,88 (14)	10,94 (7)

A completely different situation is observed in the surveyed KarU women (Table 3). The largest number of female teachers turned out to be in rank III (35.94%), i.e. they age at the same rate as the population. Slightly less number of them are ageing slower (31.25%) and the remaining one-third of female teachers are subject to accelerated ageing (32.78%). And this group of women teachers is 2.4 times smaller than that of men! Thus, the rapid, pandemic related reorganization of the teaching process into distance learning during the pandemic resulted in much more negative impact on the organism of men compared to women, which can be explained, apparently, by the peculiarities of the reaction to stress of the male organism.

We obtained similar trends in the gender aspect in the survey of teachers at AltSU (Table 4).

The table shows that in the group of men 9.52 % of surveyed teachers fell into the I and II ranks, the rate of ageing in this category is slow, which indicates good health reserves. The ageing rate of 23.81% (rank II) of the teachers corresponds to the population standard, which is 2.5 times more than in KarU (Table 3).

Table 4. Ranking of BA indicator of AltSU teachers, men and women (%)

n-21	BA Men's Ranks				
	I	II	III	IV	V
	- (0)	9,52 (2)	23,81 (5)	52,38 (11)	14,29 (3)
n-38	BA Women's Ranks				
	18,42 (7)	15,79 (6)	34,21 (13)	13,16 (5)	18,42 (7)

At the same time, a significant group of male teachers (66.67%) has an accelerated ageing rate, i.e. they are in a borderline state of health; this group, however, is less than in KarU by 16%.

At the same time, we obtained different data for AltSU women than for men. One third (34.21%) of the female teachers surveyed have a slower ageing rate. The same proportion of female teachers meets the population standard, and one third (31.58 per cent) of female teachers with accelerated ageing rate. (Table 4). We obtained similar data in women in KarU (Table 2).

Thus, our study of physical health according to the BA indicator shows the essential role of social environment for optimal functioning of the leading morpho-functional systems of the organism. The most significant stress factor causing the tension of adaptation mechanisms for the organism of a teacher was the urgent transition to the distance form of education, associated with new unlearned forms and methods of teaching, changes in the habitual way of life. This is evidenced by the transition to the health risk group of half of the surveyed teachers. And even the return to the traditional way of teaching, preadaptation, did not return the organism of the examined teachers to the initial physiological positions. It should be especially noted that the male organism reacted more negatively in this stressful situation. It is well established that exposure to stress activates the hypothalamic–pituitary–adrenal (HPA) axis in both males and females, leading to increased secretion of cortisol and adrenaline. Nevertheless, sex-related differences exist in the physiological stress response. In women, estrogens have been shown to mitigate the effects of cortisol, thereby moderating the overall neuroendocrine response to stress [19, 20, 21].

Conclusions

The urgent transition of higher education institutions to the distance form of education in connection with the pandemic and even after the pandemic to the traditional form of education affected physical health according to the biological age indicator - half of the surveyed teachers were in the health risk group.

The obtained results indicate gender differences in the functioning of the leading morpho-functional systems of the organism – the male organism experiences chronic stress to a greater extent.

References:

1. Биологический возраст и старение: возможности определения и пути коррекции: руководство. Кишкун А.А. - 2008. – 976 с. - ISBN 978-5-9704-0786-8.
2. Markelj, N., Kovač, M., Leskošek, B., & Jurak, G. (2024). Occupational health disorders among physical education teachers compared to classroom and subject specialist teachers. *Frontiers in Public Health*, 12, Article 1390424. <https://doi.org/10.3389/fpubh.2024.1390424>
3. Issayeva S.M. Contemporary view at sarcopenia (literature review) / S.M. Issayeva, M.A. Bissembay // *Medicine*. – 2019. – V.3(201). - P.61-65.
4. Gao, X., Cheng, M., & Zhang, R. (2024). The relationship between physical activity and the health of primary and secondary school teachers: The chain mediating effects of body image and self-efficacy. *BMC Public Health*, 24, 562. <https://doi.org/10.1186/s12889-024-17914-2>
5. С.Г. Абрамович, И.М. Михалевич, А.В. Щербакова, Н.А. Холмогоров. Способ определения биологического возраста человека // *Медицинский журнал*, 2014, № 1. – с.45-48.
6. Гурьева, А.Б., Алексеева, В.А., Петрова, П.Г., & Николаев, В.Г. (2015). Характеристика биологического возраста женщин-якуток разных возрастных групп. *Современные проблемы науки и образования*, (6). <https://science-education.ru/ru/article/view?id=23818>.
7. Westphal, A., Kalinowski, E., Hoferichter, C.J., & Vock, M. (2022). K–12 teachers' stress and burnout during the COVID-19 pandemic: A systematic review. *Frontiers in Psychology*, 13, 920326. <https://doi.org/10.3389/fpsyg.2022.920326>
8. Grabara, M. (2023). The association between physical activity and musculoskeletal disorders: A cross-sectional study of teachers. *PeerJ*, 11, e14872. <https://doi.org/10.7717/peerj.14872>
9. Рахимжанова А.Р., Тнимова Г.Т., Курбанова Г.Д., Карабаева А.Б. Методология и методы исследования интегрального здоровья индивида. – Методическое пособие- практикум. – Павлодар, 2014. – 66 с.
10. Gómez-Domínguez, V., Navarro-Mateu, D., Prado-Gascó, V. J., & Gómez-Domínguez, T. (2022). How Much Do We Care about Teacher Burnout during the Pandemic: A Bibliometric Review. *International Journal of Environmental Research and Public Health*, 19(12), 7134. <https://doi.org/10.3390/ijerph19127134>

11. Yingying, S., Khaizer Omar, M., & Ismail, N. (2025). Job stress and burnout among lecturers: a systematic literature review and meta-analysis. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2025.1673812>
12. Войтенко В.П. Биологический возраст. Наследственность и старение. / Войтенко В.П., Полухов А.М., Барбарук Л.Г. и др. Войтенко В.П., Полухов А.М., Барбарук Л.Г. и др. // Геронтология и гериатрия. - Киев, 1984. – С. 5-15.
13. В.И. Донцов, В.Н. Крутько. Биологический возраст как метод системной оценки онтогенетических изменений состояния организма. - Онтогенез, 2015, том 46, № 5, с. 295–303. - Институт системного анализа РАН 117312, Москва, пр. 60-летия Октября.
14. Салагай, Ю.В. Оценка стресс-факторов в профессиональной деятельности преподавателей высшей школы / Ю.В. Салагай, Л.Г. Галина // Известия Саратовского университета. Новая серия. Серия: Акмеология образования. Психология обучения. Педагогика. - 2020. - Т. 10, № 3. - С. 299-306.
15. Липатов, В.А., Крамер, Л.А. (2020). Физиологические особенности организма преподавателей в условиях дистанционного обучения. *Вестник Санкт-Петербургского университета*, 23(4), 532-536.
16. Гусев, В.В., Лемешевский, В.В., Шлайн, В.Е. и др. (2020). Изменение физиологического состояния преподавателей в условиях перехода на дистанционное обучение. *Российский физиологический журнал имени И.М. Сеченова*, 106(6), 835-840.
17. Agyapong, B., Obuobi-Donkor, G., Burbach, L., & Wei, Y. (2022). Stress, Burnout, Anxiety and Depression among Teachers: A Scoping Review. *International Journal of Environmental Research and Public Health*, 19(17), 10706. <https://doi.org/10.3390/ijerph191710706>
18. Zhao, W., Liao, X., Li, Q., Jiang, W., & Ding, W. (2021). The Relationship Between Teacher Job Stress and Burnout: A Moderated Mediation Model. *Frontiers in Psychology*, 12, Article 784243. <https://doi.org/10.3389/fpsyg.2021.784243>
19. Myrzabayev, A., Kabdolla, Y., Tnimova, G., Sokolova, G., Bodeyev, M., Sivolobova, O., & Kuznetsova, L. (2023). The Pre-Nosological Diagnostics of Integral Health of a University Professor. *Bangladesh Journal of Medical Science*, 22(2), 432–441. <https://doi.org/10.3329/bjms.v22i2.65008>
20. Braun, S.S., & Roeser, R.W. (2025). Conceptualizing teachers' occupational health and personal well-being for research on adult SEL: The domain-specific valence model. *Social and Emotional Learning: Research, Practice, and Policy*. <https://doi.org/10.1016/j.sel.2025.100157>
21. Tahernejad, S. et al. (2024). Musculoskeletal disorders among teachers: a systematic review and meta-analysis. *Frontiers in Public Health*. <https://doi.org/10.3389/fpubh.2024.1399552>

Information about the authors

Yerbol Kabdolla – corresponding author, Senior Lecturer at the Department of Sports and Pedagogical Disciplines, E.A. Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: Kab-1990@mail.ru; ORCID: 0009-0004-1879-8572;

Amanay Myrzabayev – Candidate of Pedagogical Sciences, Professor at the Department of Zoology, E.A. Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: mba_57@mail.ru; ORCID: 0000-0001-9472-8534;

Gulbagiza Tnimova – Doctor of Medical Sciences, Professor at the Department of Pharmaceutical Disciplines, Bolashaq Academy, Karaganda, Kazakhstan; e-mail: gulbagiza@bk.ru; ORCID: 0000-0001-5661-4579;

Marat Bodeyev – Associate Professor at the Department of Sports and Pedagogical Disciplines, Candidate of Biological Sciences, E.A. Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: marat_sport@mail.ru; ORCID: 0009-0000-3239-484X;

Sabanbayev Nurbek – Head of the Department of Physical Culture, Teaching Methodology and Sports Training, Master of Pedagogical Sciences, E.A. Buketov Karaganda National Research University, Karaganda, Kazakhstan; e-mail: Nurbol_c@mail.ru; ORCID: 0000-0003-1786-6591.