Sciences of Europe

No 179 (2025)

Sciences of Europe
(Praha, Czech Republic)

ISSN 3162-2364
The journal is registered and published in Czech Republic.
Articles in all spheres of sciences are published in the journal.

Journal is published in Czech, English, Polish, Russian, Chinese, German and French, Ukrainian.
Articles are accepted each month.
Frequency: 24 issues per year.
Format - A4
All articles are reviewed
Free access to the electronic version of journal

«Sciences of Europe» -
Editorial office: Křižíkova 384/101 Karlín, 186 00 Praha

E-mail: info@european-science.org
Web: www.european-science.org

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СИНЕ-ЗЕЛЕНЫЕ И ЗЕЛЕНЫЕ ВОДОРОСЛИ, РАСПРОСТРАНЕННЫЕ НА КРУПНЫХ РЕКАХ НАХЧЫВАНСКОЙ АВТОНОМНОЙ РЕСПУБЛИКИ

Кахраманов С.Г.
ORCID: 0009-0003-9200-5270
Канд. биол. наук, Министерство науки и образования Азербайджанской Республики, Институт Биоресурсов (Нахчыван), Нахчыван, Азербайджан

BLUE-GREEN AND GREEN ALGAE COMMON IN LARGE RIVERS OF THE NAKHCHIVAN AUTONOMOUS REPUBLIC

Kahramanov S.
ORCID: 0009-0003-9200-5270
PhD in Biology, Ministry of Science and Education of the Republic of Azerbaijan, Institute of Bioresources (Nakhchivan), Nakhchivan, Azerbaijan
DOI: 10.5281/zenodo.18082853

АННОТАЦИЯ

Альгологические исследования проводились в ряде районов Азербайджана. Анализ видового состава водорослей рек даёт представление об общем состоянии водной экосистемы. При оценке экологического состояния рек важно учитывать особенности развития водорослей разных экологических групп. Одним из важных этапов исследований стало изучение флоры и таксономического состава водорослей как проточных водоемов в целом, так и отдельных стационарных участков [5, 14]. Ряд исследователей, изучая сине-зеленые и зеленые водоросли в реках, отметили, что видовые и подвидовые таксоны в альгофлоре наиболее распространены в летние месяцы. Виды распространены преимущественно на участках рек со средней скоростью течения или в стоячих водоёмах вне общего русла. На пойменных участках встречена незначительная часть общей альгофлоры. При экологической группировке отмечено также неравномерное распределение видов по родам и семействам [3, 4, 6, 9].

ABSTRACT

Algological studies were conducted in several regions of Azerbaijan. Analysis of the species composition of river algae provides insight into the overall health of the aquatic ecosystem. When assessing the ecological state of rivers, it is important to take into account the development characteristics of algae of different ecological groups. One of the important stages of the research was the study of the flora and taxonomic composition of algae in both flowing water bodies as a whole and in individual stationary areas [14, 15]. A number of researchers studying blue-green and green algae in rivers have noted that species and subspecies taxa in the algal flora are most common during the summer months. These species are found primarily in sections of rivers with moderate flow rates or in stagnant bodies of water outside the main riverbed. A small portion of the total algal flora was found in floodplain areas. Ecological grouping also revealed an uneven distribution of species across genera and families [3, 4, 6, 9].

Ключевые слова: Сине-зеленые и зеленые водоросли, род, вид, экология, алгофлора

Keywords: Blue-green and green algae, genus, species, ecology, algoflora

Материал и методика

В качестве объектов исследования были выбраны следующие реки Нахчыванской Автономной Республики: Нахчыванчай, Гиланчай, Алинджачай, Арпачай.

Рисунок 1. Маршруты экспедиций и свободных маршрутов для отбора проб водорослей.

В ходе экспедиций и выбранных свободных маршрутов в 2025 г. отбор проб водорослей проводился фитопланктонной сетью № 77, а сбор эпифитных водорослей на субстратах осуществлялся соскабливанием ножом по общепринятой методике на заранее выбранных постоянных стационарных пунктах, расположенных в разных участках рек, озерах и водохранилищах.

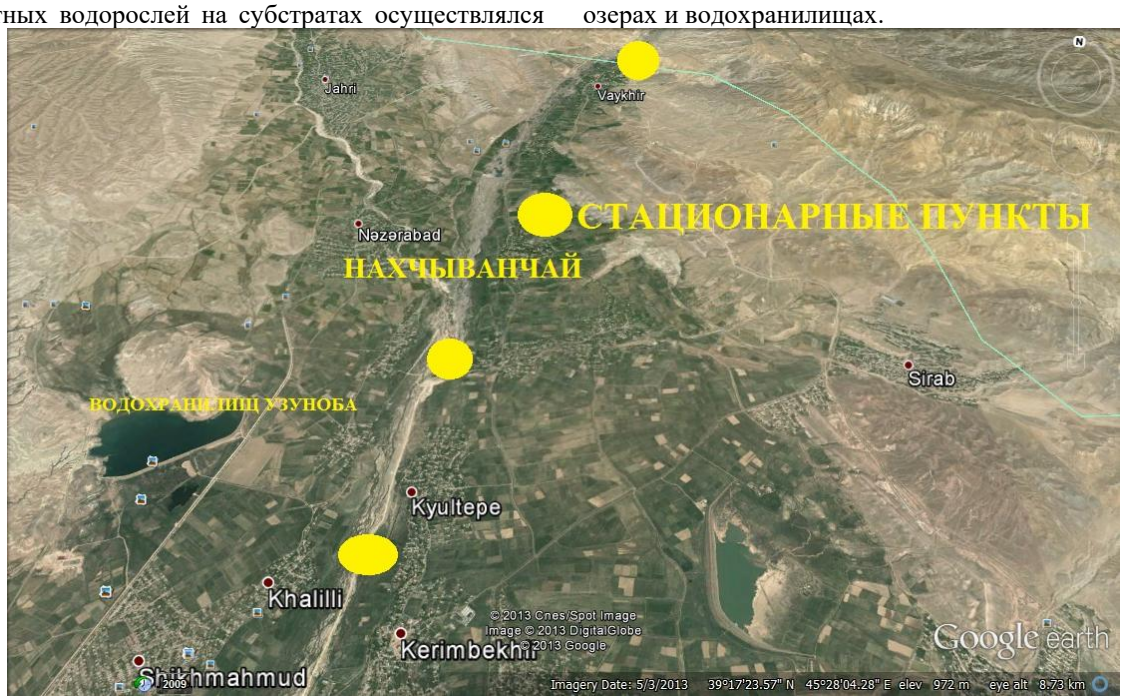


Рисунок 2. Река Нахчыванчай. Постоянные стационарные пункты сбора проб.

Рисунок 3. Река Гиланчай. Постоянные стационарные пункты сбора проб.

Рисунок 4. Река Алинджачай. Постоянные стационарные пункты сбора проб

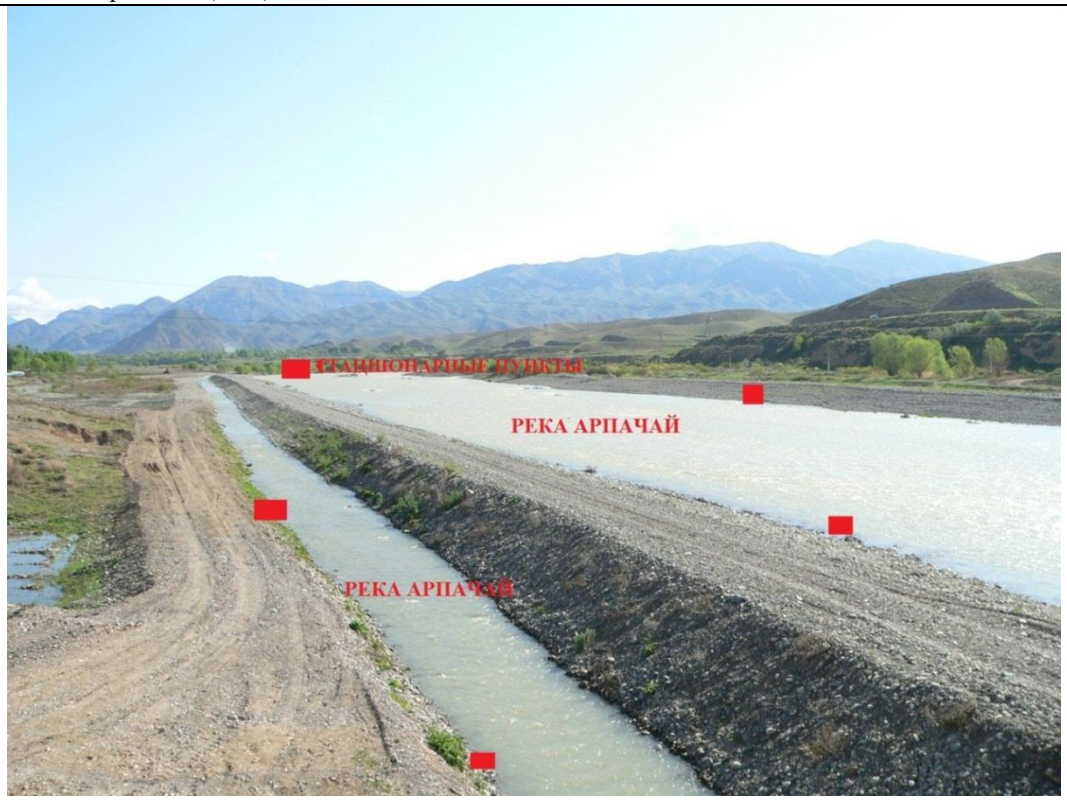


Рисунок 5. Река Арпачай. Постоянные стационарные пункты сбора проб.

Образцы водорослей собирали преимущественно в ясную, солнечную погоду. Образцы из мелководных источников собирали с поверхности воды с помощью металлической чашки. В ясную погоду водоросли, образующие облако образную губчатую массу вокруг стеблей водных растений, собирали вручную. Если на этих растениях обнаруживалась зелёная или серая слизь, всё водное растение переносили в чашку для образцов и добавляли воду из этого водоёма [7, 8, 13].

Микроскопические исследования собираемых образцов проводились, пока они были ещё свежими. Собранные водоросли определяли микроскопическим исследованием и определением их видового состава в свежем состоянии [1, 2, 10, 11, 12]. Для хранения образцы фиксировали в 5% растворе формалина. Таксономическую структуру сине-зеленых и зеленых водорослей по отделам и родам уточняли в соответствии с современными Международными номенклатурами 1999-2025 гг.: Itis, Eol и Biolib. cz/en - [15, 16, 17].

Результаты и их обсуждений

Проводилось сравнительное изучение флоры водорослей с изменением температуры воды в разные месяцы на отдельных стационарных пунктах, расположенных на разных высотах над уровнем моря и выбранных постоянно. Здесь обнаружена корреляция между разнообразием сине-зеленых и зеленых водорослей и повышением температуры воды (с июня по конец сентября). Таким образом, с повышением температуры воды наблюдалось увеличение, как плотности водорослей, так и их видового разнообразия. В связи с понижением температуры воздуха после сентября численность водорослей начала снижаться, особенно в отдельных стационарных пунктах в верховьях рек. В зимний период (декабрь-февраль) число видов снижалось до минимума (7–12). Однако в пробах, отобранных на стационарных пунктах в пойме реки, число видов сине-зеленых и зеленых водорослей было относительно высоким.

Naxçıvançay – Cyanobacteriophyta Oren, Mareš et Rippka: -1. *Synechococcus elongatus* Nägeli, 1849, 2. *Sy. aeruginosus* Nägeli, 1849, 3. *Sy. cedrorum* 4. C. Sauvageau, 1892, 5. *Synechocystis aquatilis, 6. Merismopedia *tenuissima* E. Lemmermann, 1898, 7. **M. glauca* (Ehrenberg) F.T. Kützing, 1845, 8. *Microcystis aeruginosa* (F.T. Kützing 1833), 9. *O. chlorina* F.T. Kützing *et al* Gomont, 1892, 10. *O. acuminata* Gomont, 1892, 11. *Plectonema* Thuret et al Gomont, 1892 *battersii* Gomont, 1899, 12. *Schizothrix* F.T. Kützing et al Gomont, 1892 *mullerii* Nageli et al Gomont, 1849, 13. *Sch. fragilis* F.T. Kützing et al Gomont (1892), 14. *Aphanizomenon* A. Morren et al Bornet et al Flahault, 1888 A. 15. *Aphanizomenon flos-aquae* Ralfs et al Bornet et al Flahault, 1886; *Chlorophyta* Reichenbach - *Ulothrix*: 1. *oscillarina* F.T. Kützing, 1845, 2. *U. moniliformis* F.T. Kützing, 1849, 3. *Chlamydomonas polychloris* (Korschikoviella Silva) 1938, 4. *Tetrapedia gothica* Reinschiana, 5. *Ankistrodesmus arcuatus* (Korschikoviella Silva Hindák, 1970, 6. *Spirogyra calospora,*7. *S. decimina* (O.F.Müller) F.T. Kützing, Dumortier, 1822, 8. *Cosmoastrum orbiculare* (Ralfs) G.H.Tomaszewicz, 9. *C. Gladiosum, 10. Cosmarium granatum* Brebisson et al Ralfs, 1848, 11. *C. subexscavatum* West et al G.S.West, 1900, 12. *C. variolatum* P. Lundell, 1871, 13. *Chlorella vulgaris* Beyerinck [Beijerinck], 8910, 14. *Actinotaenium cucurbitinum* (Bisset) Teiling, 1954, 15. *Staurastrum bacillare* Brebisson et al Ralfs, 1848, 16. *S. gracile* Ralfs et al Ralfs, 1848.

Gilançay – Cyanobacteriophyta Oren, Mareš et Rippka: - 1. *Merismopedia elegans* A.Braun ex F.T. Kützing, 1849, 2. M. *brevis* (F.T. Kützing) et al Gomont, 1892, 3. *Merismopedia muscicola* (Meneghini) Elenkin, 1938 [=*Aphanocapsa muscicola* (Meneghini) Wille], 4. *Synechocystis aquatilis,* 5. *S. aeruginosus* Nägeli, 1849, 6. *Oscillatoria* Vaucher et al Gomont, 1892, 7. *O. chlorina* F.T. Kützing *et al* Gomont, 1892, 8. *Phormidium* F.T. Kützing et al Gomont, 1892* *fragile* (Meneghini) Gomont, 1892, 9. *Anabaena* Bory et al Bornet et al Flahault de Saint - Vincent, 1886 *variabilis* F.T. Kützing, 1843, 10. *A. constricta* (Szafer) Geitler, 1925: - *Chlorophyta* – 1. *Ulothrix subtilissima* Rabenhorst, 1857, 2. *Chlamydomonas sectilis* Korschikoviella in Pascher, 1927, 3. *Pediastrum duplex* Meyen, 1829, 4. *Tetrapedia reinschiane* W. Archer, 1866, 5. *Spirogyra calospora* Cleve*, Spirogyra decimina* (O.F.Müller) F.T. Kützing, Dumortier, 1822, *6. Chlorella vulgaris* Beyerinck [Beijerinck], 8910, 7. *Cosmoastrum hystrix* (Ralfs) Palamar-Mordvintzeva, 8. *Cosmarium formosulum* Hoffman in Nordstedt, 1888, 9. *C. subexscavatum* West et al G.S.West, 1900, *C. subquadratum* Nordstedt, 1876 10. *Cosmocladium pussillum* L. Hilse, 11. *Desmidium aptogonum* Brebisson et al F.T. Kützing, 184.

Əlincəçay – Cyanobacteriophyta Oren, Mareš et Rippka: 1. *Synechococcus aeruginosus* Nägeli, 1849, 2. *Merismopedia elegans* A.Braun ex F.T. Kützing, 1849, 3. M. *brevis* (F.T. Kützing) et al Gomont, 1892, *4. Synechocystis aquatilis, 5. M. muscicola* (Meneghini) Elenkin, 1938 [=*Aphanocapsa muscicola* (Meneghini) Wille], 6. *Oscillatoria* Vaucher et al Gomont, 1892, *7. O. acuminata* Gomont, 1892, 8. *Phormidium* F.T. Kützing et al Gomont, 1892, 10. *Ph. fragile* (Meneghini) Gomont, 1892* 11. *Anabaena* Bory et al Bornet et al Flahault de Saint - Vincent, 1886 *variabilis* F.T. Kützing, 1843, 12. *Aphanizomenon* A. Morren et al Bornet et al Flahault, 1888 *flos-aquae* Ralfs et al Bornet et al Flahault, 1886; *Chlorophyta* -1. *Ulothrix subtilissima* Rabenhorst, 1857, 2. *U. oscillarina* F.T. Kützing, 1845, 3. *Chlamydomonas sectilis* Korschikoviella in Pascher, 1927, 4. *Pediastrum duplex* Meyen, 1829, 5. *Tetrapedia reinschiane* W. Archer, 1866, 6. *Spirogyra calospora* Cleve*, Spirogyra tenuissima* (Hassall) F.T. Kützing, 1849, 7. *Chlorella vulgaris* Beyerinck [Beijerinck], 8910, 8. *Cosmoastrum hystrix* (Ralfs) Palamar-Mordvintzeva, 9. *Cosmarium formosulum* Hoffman in Nordstedt, 1888, 12. *C. granatum* Brebisson et al Ralfs, 18481, 13. *C. subquadratum* Nordstedt, 1876, 14. *Cosmocladium pussillum* L. Hilse, 15. *Desmidium aptogonum* Brebisson et al F.T. Kützing, 184.

Arpaçay - Cyanobacteriophyta Oren, Mareš et Rippka 1. *Microcystis parietina* (Nageli) Elenkin in Engler-Prantl, 1938 [=*Aphanocapsa parietina* Nageli], 2. *M. brevis* (F.T. Kützing) et al Gomont, 1892, 3. *Synechocystis aquatilis,* 4. *Merismopedia. muscicola* (Meneghini) Elenkin, 1938 [=*Aphanocapsa muscicola* (Meneghini) Wille], 5. *Oscillatoria* Vaucher et al Gomont, 1892, 6. *O. chlorina* F.T. Kützing *et al* Gomont, 1892, 7. *Schizothrix* F.T. Kützing et al Gomont, 1892 *mullerii* Nageli et al Gomont, 1849, 8. *Sch. fragilis* F.T. Kützing et al Gomont (1892), 9. *Anabaena constricta* (Szafer) Geitler, 1925: - *Chlorophyta* Reichenbach, 1828 - 1. *Ulothrix zonata* (Weber et Mohr) F.T. Kützing, 1833 [=*Conferva zonata* Weber et Mohr; *Hormiscia zonata* (Weber et Mohr, 2. *Pediastrum duplet al* Meyen, 1829, 3. *P. muticum* F.T. Kützing, 1849, 4. *Ankistrodesmus falcatus* (Corda) Ralfs, 1848, 5. *Scenedesmus hystrix* (Ralfs) Palamar-Mordvintzeva (=*Staurastrum hystrix* Ralfs), 6. Chlorella vulgaris Beyerinck [Beijerinck 1890, 7. *Spirogyra tenuissima* (Hassall) F.T. Kützing, 1849, 8. S. sp., *Spirogyra decimina* (O.F.Müller) F.T. Kützing, Dumortier, 18229,. *Cosmarium variolatum* P. Lundell, 1871, 10. *C. bigemma* Raciborski, 11. *C. subquadratum* Nordstedt, 1876, *C. granatum* Brebisson et al Ralfs, 184812, *Actinotaenium clevei* P. Lundell) Teiling, 1954, 13. *Desmidium aptogonium* Brebisson et al F.T. Kützing, 1849, 14. *D. schwartzii* (C.A. Agardh) C.A. Agardh et al Ralfs, 1848, 15. *Staurastrum gracile* Ralfs et al Ralfs, 1848, 16. *S. tetracerum* Ralfs et al Ralfs, 1848, 17. *S. punctulatum* Brebisson in Ralfs, 1848, 18. *Oocardium stratum* Nageli, 1849, 19. *Cosmocladium pussillum* L. Hilse, 20. *Tetrapedia* Reinschiana, 1866- *gothica* Reinschiana, 1866, 21. *reinschiane* W. Archer, 1866- Reinşa.

СИСТЕМАТИКА СИНЕ-ЗЕЛЕНЫХ И ЗЕЛЕНЫХ ВОДОРОСЛЕЙ.

Отдел: Cyanobacteriophyta Oren, Mareš et Rippka

Класс: *Cyanophyceae* Hauck

Ряд: *Synechococcales* Hoffmann, Komárek & Kaštovský

Семейства: *Synechococcaceae* Komarek et al K.T. Anagnostidis, 1995

Род: *Synechococcus* Nageli, 1849

Виды: 1. *S. elongatus* Nageli, 1849

2. *Sy. aeruginosus* Nägeli, 1849,

3. *Sy. cedrorum*. C. Sauvageau, 1892,

Ряд: Chroococcales R. von Wettstein et al von Westerheim, 2002

Семейства: *Microcystaceae* Elenkin, 1933

Род: *Merismopedia* Meyen, 1839

Виды: 1. * *Merismopedia. glauca* (Ehrenberg) F.T. Kützing, 1845 [syn.: M. aeruginea Brebisson in F.T.Kützing, 1849; M. növa Wood, 1872; Agmenellum thermale sensu auct.] -

2. *M. elegans* A.Braun et al F.T. Kützing, 1849.

3. **M. tenuissima* E. Lemmermann, 1898.

4.M. *brevis* (F.T. Kützing) et al Gomont, 1892,

.Род: *Microcystis* F.T. Kützing *et al* E. Lemmermann, 1907 *nom. cons.*

Виды: 1. *M. aeruginosa* (F.T. Kützing 1833) E. Lemmermann, 1907, f. elongata C.B.Rao.

2. *M. parietina* (Nageli) Elenkin in Engler-Prantl, 1938 [=*Aphanocapsa parietina* Nageli].

3. *M. muscicola* (Meneghini) Elenkin, 1938 [=*Aphanocapsa muscicola* (Meneghini) Wille].

Род: *Synechocystis* C. Sauvageau, 1892

Вид: 1. *S. aquatilis* C. Sauvageau, 1892.

Ряд: *Oscillatoriales* Elenkin, 1934; Cavalier-Smith, 2002

Семейства: *Oscillatoriaceae* (Kirchner) Elenkin s. st. 1936; Engler, 1898

Род: *Oscillatoria* Vaucher et al Gomont, 1892

Виды: 1. **O. tenuis* J. Agardh C.A. 1813 Agardh et al Gomont, 1892.

2. *O. chlorina* F.T. Kützing *et al* Gomont, 1892.

3. *O. acuminata* Gomont, 1892.

Род: *Phormidium* F.T. Kützing et al Gomont, 1892 (*subgenera*: Geitlerinem Anagnostidis Et Komarek, 1988, Gomontinema Anagnostidis et Komarek, 1988, *Phormidium*, Hansgirgiana Anagnostidis et Komarek, 1988

Вид: **Ph. fragile* (Meneghini) Gomont, 1892.

Ряд: Leptolyngbyales Strunecky & Mares

Семейства: *Schizotrichaceae* Elenkin, 1949

Род: *Schizothrix* F.T. Kützing et al Gomont, 1892. Ann. Sci.

Вид: 1. *Sch. fragilis* F.T. Kützing et al Gomont (1892).

Ряд: Nostocales Cavalier-Smith, 2002

Семейства: *Aphanizomenonaceae* Elenkin

Род: *Anabaena* Bory et al Bornet et al Flahault de Saint - Vincent, 1886

Виды: 1. *Anabaena* Bory et al Bornet et al Flahault de Saint - Vincent, 1886 *variabilis* F.T. Kützing, 1843,

2. *A. constricta* (Szafer) Geitler, 1925.

Род: *Aphanizomenon* A. Morren et al Bornet et al Flahault, 1888

Вид: *Aphanizomenon flos-aquae* Ralfs et al Bornet et al Flahault, 1886.

Класс: *Cyanophyceae* Hauck

Ряд: *Synechococcales* Hoffmann, Komárek & Kaštovský

Семейства: *Synechococcaceae* Komarek et al K.T. Anagnostidis, 1995

Род: *Synechococcus* Nageli, 1849

Виды: 1. *S. elongatus* Nageli, 1849

2. *Sy. aeruginosus* Nägeli, 1849,

3. *Sy. cedrorum*. C. Sauvageau, 1892,

Ряд: Chroococcales R. von Wettstein et al von Westerheim, 2002

Семейства: *Microcystaceae* Elenkin, 1933

Род: *Merismopedia* Meyen, 1839

Виды: 1. * *Merismopedia. glauca* (Ehrenberg) F.T. Kützing, 1845 [syn.: M. aeruginea Brebisson in F.T.Kützing, 1849; M. növa Wood, 1872; Agmenellum thermale sensu auct.] -

2. *M. elegans* A.Braun et al F.T. Kützing, 1849.

3. **M. tenuissima* E. Lemmermann, 1898.

4.M. *brevis* (F.T. Kützing) et al Gomont, 1892,

.Род: *Microcystis* F.T. Kützing *et al* E. Lemmermann, 1907 *nom. cons.*

Виды: 1. *M. aeruginosa* (F.T. Kützing 1833) E. Lemmermann, 1907, f. elongata C.B.Rao.

2. *M. parietina* (Nageli) Elenkin in Engler-Prantl, 1938 [=*Aphanocapsa parietina* Nageli].

3. *M. muscicola* (Meneghini) Elenkin, 1938 [=*Aphanocapsa muscicola* (Meneghini) Wille].

Род: *Synechocystis* C. Sauvageau, 1892

Вид: 1. *S. aquatilis* C. Sauvageau, 1892.

Ряд: *Oscillatoriales* Elenkin, 1934; Cavalier-Smith, 2002

Семейства: *Oscillatoriaceae* (Kirchner) Elenkin s. st. 1936; Engler, 1898

Род: *Oscillatoria* Vaucher et al Gomont, 1892

Виды: 1. **O. tenuis* J. Agardh C.A. 1813 Agardh et al Gomont, 1892.

2. *O. chlorina* F.T. Kützing *et al* Gomont, 1892.

3. *O. acuminata* Gomont, 1892.

Род: *Phormidium* F.T. Kützing et al Gomont, 1892 (*subgenera*: Geitlerinem Anagnostidis Et Komarek, 1988, Gomontinema Anagnostidis et Komarek, 1988, *Phormidium*, Hansgirgiana Anagnostidis et Komarek, 1988

Вид: **Ph. fragile* (Meneghini) Gomont, 1892.

Ряд: Leptolyngbyales Strunecky & Mares

Семейства: *Schizotrichaceae* Elenkin, 1949

Род: *Schizothrix* F.T. Kützing et al Gomont, 1892. Ann. Sci.

Вид: 1. *Sch. fragilis* F.T. Kützing et al Gomont (1892).

Ряд: Nostocales Cavalier-Smith, 2002

Семейства: *Aphanizomenonaceae* Elenkin

Род: *Anabaena* Bory et al Bornet et al Flahault de Saint - Vincent, 1886

Виды: 1. *Anabaena* Bory et al Bornet et al Flahault de Saint - Vincent, 1886 *variabilis* F.T. Kützing, 1843,

2. *A. constricta* (Szafer) Geitler, 1925.

Род: *Aphanizomenon* A. Morren et al Bornet et al Flahault, 1888

Вид: *Aphanizomenon flos-aquae* Ralfs et al Bornet et al Flahault, 1886.

Отдел: *Chlorophyta* Reichenbach, 1828, emend. Pascher, 1914, emend. Lewis et al McCourt, 2004

Класс: *Ulvophyceae Ulvophyceae* K.R. Mattox et al K.D. Stewart, 1978

Ряд: *Ulotrichales* Borzi, 1895

Семейства: *Ulotrichaceae* F.T. Kützing, 1843

Род: *Ulothrix* F.T. Kützing, 1833

Виды: 1. *Ulothrix tenuissima* F.T. Kützing, 1833 (=*U. tenuis* F.T.Kützing; *Hormiscia tenuis* De Toni).

2. *U. zonata* (Weber et Mohr) F.T. Kützing, 1833 [=*Conferva zonata* Weber et Mohr; *Hormiscia zonata* (Weber et Mohr) Aresch].

3. *U. oscillarina* F.T. Kützing, 1845.

4. *U. moniliformis* F.T. Kützing, 1849.

5. *U. subtilissima* Rabenhorst, 1857.

Класс: *Chlorophyceae* Wille, in E. Warming, 1884

Ряд: Volvocales Oltmanns

Семейства: *Chlamydomonadaceae* F. Stein, 1878

Род: *Chlamydomonas* C.G. Ehrenberg, 1833 [1834]

Виды: 1. *Ch. polychloris* (Korschikoviella Silva) 1938, Pascher et al R. Jahoda.

2. *Ch. sectilis* Korschikoviella in Pascher, 1927.

Ряд: Sphaeropleales Luerssen

Семейства: *Hydrodictyaceae* Dumortier

Род: *Pediastrum* Meyen, 1829

Вид: 1. *Pediastrum duplex* Meyen, 1829

2. *P. muticum* F.T. Kützing,

Род: *Tetrapedia* Reinschiana, 1866

Виды: 1. *Tetrapedia gothica* Reinschiana, 1866.

2. *T. reinschiane* W. Archer, 1866.

Класс: Trebouxiophyceae Friedl

Ряд: Chlorellales H.C.Bold & M.J.Wynne

Семейства: *Chlorococceae* Brunnthaler

Род: *Chlorella* Beyerinck-Xlorella

Вид: 1. *Chlorella vulgaris* Beyerinck [Beijerinck], 8910.

Ряд: *Sphaeropleales* Luerssen

Семейства: Selenastraceae Blackman & Tansley

Род: *Ankistrodesmus* Corda, 1838

Виды: 1. *Ankistrodesmus falcatus* (Corda) Ralfs, 1848 (Corda) Ralfs *var. Falcatus.*

2. *A. arcuatus* (Korschikoviella Silva Hindák, 1970.

Семейства: *Scenedesmaceae* Oltmanns, 1904

Род: *Scenedesmus* F.J.F. Meyen, 1829

Вид. *Scenedesmus hystrix* (Ralfs) Palamar-Mordvintzeva (=*Staurastrum hystrix* Ralfs),

Класс: Zygnematophyceae Round ex Guiry

Ряд: Spirogyrales S.Hess & J.de Vries

Семейства: Spirogyraceae Bessey

Род: *Spirogyra* Link In C. G. Nees, 1820 (=*Conferva* O.F. Müller, pr. p.; *Mougeotia* C.Agardh; pr. p. *Zygnema* C.Agardh pr. p.; *Rynchonema* F.T. Kützing; *Degagnya* Conard; *Temnogyra* Lewis

Виды: 1. *S. decimina* (O.F.Müller) F.T. Kützing, Dumortier, 1822.

2. *S. tenuissima* (Hassall) F.T. Kützing, 1849.

3. *S. calospora* Cleve.

4. *S. sp.*

Ряд: *Desmidiales* Bessey

Семейства: *Desmidiaceae* Ralfs (1848)

Род: *Cosmoastrum* Palamar-Mordvintzeva (1976) (=*Staurastrum* F.J.F. Meyen pr. p.).

Виды: 1. 4. *C. gladiosum* Turner Palamar-Mordvintzeva (=*Staurastrum gladiosum* Turner).

5. *C. orbiculare* (Ralfs) G.H.Tomaszewicz; Palamar Mordvintzeva (=*Staurastrum orbiculare* Ralfs).

Cins: *Cosmarium* Corda et al Ralfs, 1848

Виды: 1. *Cosmarium. granatum* Brebisson et al Ralfs, 1848.

2. *C. variolatum* P. Lundell, 1871.

3. *C. formosulum* Hoffman in Nordstedt, 1888.

4. *C. bigemma* Raciborski.

5. *C. subquadratum* Nordstedt, 1876.

Род: *Actinotaenium* (Nageli) Teiling, 1954

Виды: 1. *A. clevei* P. Lundell) Teiling, 1954 [=*Penium cleve* P. Lundell; *Cosmarium cleve* (P. Lundell) Lütkem.].

2. *A. cucurbitinum* (Bisset) Teiling, 1954.

Род: *Cosmocladium* Brebisson, 1856

Вид:1. *C. pussillum* L. Hilse.

Род: *Desmidium* C.A. Agardh, 1848

Виды: 1. *D. aptogonum* Brebisson et al F.T. Kützing, 1849.

2. *D. schwartzii* (C.A. Agardh) C.A. Agardh et al Ralfs, 1848.

Род: *Staurastrum* F.J.F. Meyen, 1828, (s. str.)

Виды: 1. *S. gracile* Ralfs et al Ralfs, 1848.

3. *S. bacillare* Brebisson et al Ralfs, 1848.

4. *S. tetracerum* Ralfs et al Ralfs, 1848.

5. *S. punctulatum* Brebisson in Ralfs, 1848.

Род: *Oocardium* Naegeli, 1849

Вид: 1. *O. stratum* Nageli, 1849.

Виды встречались преимущественно на участках рек со средней скоростью течения. В частности, в стоячих водоёмах вне русла реки численность видов сине-зелёных и зелёных водорослей преобладала по сравнению с течением.

Литература

1. Голлербах М.М., Косинская Е.К., Полянский В.И. Определитель пресноводных водорослей СССР, М. 1953, 327 с.

2. Забелина М.М., Киселев И.А., Прошкина-Лавренко А.И., Шешуков В.С. Определитель пресноводных водорослей СССР, М. 1951, 611 с.

3. Зареи Дарки Б. *Cyanoprokaryota* разнотипных водоемов Ирана. Исламский Флаварджанский Азад ун -т, кафедра биологии (Исфахан), Иран // Альгология, 2010, т, 20. № 4, с. 482-491

4. Karayeva N.I. Preliminary studies of the Caspian vegetation of macrophytes with regard to contamination // Intern. Journ. on Algae, v. 5, № 2, 2003, s. 96-104.

5. Кахраманов С.Г. Распространение синезеленых и зеленых водорослей в озерно-речных системах Нахчыванской Автономной Республики // Materiály VIII mezinárodni vědecko - praktikà konference “Věda a technologie: krok do budoucnosti - 2012”. (27 ŭnora – 05 brezen 2012 roku) – Dil 29. Biologickě vědy: Praha. c. 10-15

6. Кахраманов С.Г. Таксономическая структура и эколого-географическая характеристика сине-зеленых и зеленых водорослей Нахчыванской Автономной республики Азербайджана / Кахраманов Сейфали Гамид оглы. // Политематический сетевой электронный научный журнал Кубанского государственного аграрного университета (Научный журнал КубГАУ) [Электронный ресурс].-Краснодар: КубГАУ, 2014, № 01(095) - IDA [article ID]: 0951401003. импакт-фактор РИНЦ=0,346 С. 46-57

7. Методика изучения биогеоценозов внутренних водоемов. АН СССР, Институт Биологии Внутренних вод. Отв. редактор Ф.Д. Мордухой-Болтовской. М., 1975, 240 с.

8. Михеева Т.М., Свирид А.А, Хурсевич Г.К., Лукьянова Е.В. Водоросли планктона водоемов и водотоков Национального парка «Припятский» / Под ред. Т.М. Михеевой. – Минск: Право и экономика, 2016.

9. Мухтарова Ш.Дж., Джафарова С.К. Географический анализ альгофлоры водоемов южного склона Большого Кавказа (Азербайджан) // Теоротической и прикладной проблемы агропромного комплекса, 2012, № 2, с. 31-35

10. Основы альгологии. Пер. с англ.- М. Мир, 1990, 597 с.

11. Определитель пресноводных водорослей СССР. Вып. 10 (1). Мошкова Н.А., Голлербах М.М., Зеленые водоросли. Класс улотриксовые, (1) – Л.: Наука, 1986, 320 с.

12. Паламарь-Мордвинцева Г.М. Определитель пресноводных водорослей СССР. Зеленые водоросли. Порядок Десмидиевые, Л., 1982, вып. 11 (2), 620 с.

13. Руководство по методам гидробиологического анализа поверхностных вод и донных отложений. Под ред. Канд. Биол. Наук В.А. Абакумова, Ленинград: Гидрометеоиздат, 1983, 239 с.

14. Gahramanov S. H. Seasonal spreading dynamics of blue-green and green algae in the water bodies of the Nakhchivan Autonomous Republic, Azerbaijan // International Journal of Multidisciplinary Research and Development, Impact Factor 3,762, 2015, v. 2(4), p. 108-110. Url: www: allsubjectjournal.com

15. https://www.biolib.cz/en/participate/

16. https://itis.gov/

17. https://eol.org/resources/1174

CHEMICAL SCIENCES

ТЯЖЕЛЫЕ МЕТАЛЛЫ В ПРИВОКЗАЛЬНЫХ ПОЧВАХ ЗАПАДНОЙ ГРУЗИИ ПО ЛИНИИ ЗЕСТАФОНИ – БАТУМИ

Ахалбедашвили Л.,
Тодрадзе Г.,
Кваташидзе Р.,
Лория Н.,
Джанашвили Н.,
Джалагания С.,
Гагниашвили Н.,
Сургуладзе Р.,
Брокишвили М.,
Уклеба М.
Тбилисский Государственный Университет им. Ив. Джавахишвили, Кавказский Институт Минерального Сырья им. А. Твалчрелидзе

HEAVY METALS IN RAILWAY STATION SOILS IN WESTERN GEORGIA ALONG THE ZESTAPONI-BATUMI LINE

Akhalbedashvili L.,
Todradze G.,
Kvatashidze R.,
Loria N.,
Janashvili N.,
Jalaghania S.,
Gagniashvili N.,
Surguladze R.,
Brokishvili M.,
Ukleba M.
Ivane Javakhishvili Tbilisi State University Alexandre Tvalchrelidze Caucasian Institute of Mineral Resources, Tbilisi, Georgia
DOI: 10.5281/zenodo.18083831

АННОТАЦИЯ

Железнодорожный транспорт является мощным источником загрязнения территории тяжелыми металлами. В данной работе проведен сравнительный анализ содержания и распределения форм соединений химических элементов в почвах железнодорожных станций Западной Грузии от станции Зестафони через Самтредиа, Абаша, Сенаки, Поти, Кобулети до Батуми. Исследования показали, что прижелезнодорожные пространства значительно загрязнены валовыми, но не подвижными формами тяжелых металлов, которые составляют не более 2 % от общего количества полютанта. По общему количеству полютантов наиболее загрязненными являются портовые крупные города Поти и Батуми, наименее загрязненными малые Самтредиа и особенно Абаша. Но на основании расчета суммарного показателя загрязнения ∑ Кс последовательность изменилась существенным образом: Сенаки → Зестафони → Батуми → Поти → Кобулети → Самтредиа → Абаша.

ABSTRACT

Railway transport is a significant source of heavy metal pollution. This study presents a comparative analysis of the content and distribution of chemical elements in soils at railway stations in Western Georgia, from Zestafoni station through Samtredia, Abasha, Senaki, Poti, Kobuleti, and to Batumi. The study showed that railway sections are significantly contaminated with heavy metals in gross content, but not in mobile, form; their share in the total pollutant content does not exceed 2%. In terms of total pollutant content, the large port cities of Poti and Batumi are the most polluted, while the smaller towns of Samtredia and, especially, Abasha are the least polluted. However, based on the calculation of the total pollution index ∑ Kc, the sequence has changed significantly: Senaki → Zestafoni → Batumi → Poti → Kobuleti → Samtredia → Abasha.

Ключевые слова: почва, загрязнение, тяжелые металлы, железнодорожные станции.

Keywords: soil, pollution, heavy metals, railway stations.

В настоящее время экономический рост Грузии в значительной степени зависит от туристической и транспортной инфраструктуры страны, евразийского транспортного коридора, так называемого «Шелкового пути». Развитие этих структур, в свою очередь, приводит к интенсивному загрязнению атмосферы, водоемов и почвы. Поэтому работа, направленная на изучение, мониторинг и снижение негативного воздействия химических загрязнителей на окружающую среду нашей страны,

чрезвычайно актуальна. Это особенно важно для курортных и туристических зон.

Железнодорожный транспорт является одним из наиболее перспективных и развитых видов транспорта, однако его вклад в загрязнение окружающей среды практически не изучен. Железные дороги, как универсальный вид транспорта, перевозят все добытые, переработанные и синтетические химические вещества. К ним относятся краски, минералы, минеральные удобрения, растворители, пестициды, соединения тяжелых металлов и нефтепродукты. Кроме того, при техническом обслуживании, текущем ремонте и эксплуатации подвижного состава используются опасные химические материалы и вещества, что, в свою очередь, приводит к загрязнению почвы и окружающей среды в целом в случае различных утечек или нарушений техники безопасности.

Особую угрозу представляет загрязнение почвы тяжелыми металлами [1-4]. Большая часть загрязняющих веществ сорбируется в почве, остальные мигрируют в поверхностные и грунтовые воды. Особенно важно защищать почву от загрязнения, поскольку любое вредное соединение, обнаруженное в почве, рано или поздно попадает в организм человека либо по цепи почва → растение →человек, либо почва → растение → животное → человек [5,6].

Поэтому загрязнение почвенного покрова железнодорожных путей является одной из проблем современной экологии, имеющей первостепенное социально-экономическое значение. Оценка загрязнения почвы и качества восстановления актуальна для решения вопросов охраны окружающей среды и труда, поскольку заражение человека может произойти во время работ по техническому обслуживанию и строительству железных дорог. Количество загрязняющих веществ, попадающих на пути, колеблется от 5 до 20 г на 1 кг почвы. Ежегодно на каждый километр пути из легковых автомобилей выливается 200 $м^3$ сточных вод, что приводит к бактериологическому загрязнению почвы. Содержание железа, свинца, цинка, хрома и меди в почве вблизи железной дороги превышает максимально допустимую концентрацию в 2-25 раз. Загрязняющие вещества, попадающие в почву, сохраняются десятилетиями, загрязняя воздух и воду, накапливаясь в растениях и передаваясь животным организмам по трофической цепи.

До настоящего времени достаточно широко изучалось попадание тяжелых металлов в почву из природных и антропогенных источников: автомобильный транспорт, предприятия цветной и черной металлургии, карьеры и шахты, сжигание различных отходов и сжигание угля на электростанциях. Влиянию железнодорожного транспорта на содержание тяжелых металлов в почве и растениях вблизи путей уделялось гораздо меньше внимания [7].

В то же время это имеет большое значение как для изучения процессов, происходящих в экосистемах, так и для решения многих других практических задач, связанных с охраной окружающей среды.

За 150 лет эксплуатации химический состав почвы в районах, окружающих грузинские железнодорожные станции, не изучался. Несмотря на то, что грузовые поезда переводились на резервную линию и останавливались на станциях. Вследствие этого территория городских станций сильно загрязнена химическими токсикантами из-за утечек и распыления. Наши предварительные исследования показали, что содержание тяжелых металлов в почве станций превышает максимально допустимые уровни в 100 раз и более [8]. Кроме того, железнодорожный транспорт является мощным источником загрязнения территории нефтепродуктами. Он активно участвует в миграционном потоке веществ в почву. Эти опасные данные легли в основу настоящей работы.

Целью исследования являлось провести сравнительный анализ содержания и распределения форм соединений химических элементов в почвах железнодорожных станций Западной Грузии, и в дальнейшем оценить влияние на них природных и антропогенных факторов. Определить коэффициенты концентрации и подвижные формы отдельных элементов и суммарный показатель химического загрязнения выделенных станций, определить взаимосвязи между содержанием химических элементов в почве и близлежащих растениях.

Объектами исследования были почвы и растения на фоновых, антропогенно- преобразованных и техногенно загрязненных территориях основных узловых станций Западной Грузии от станции Зестафони, через Самтредиа, Абаша, Сенаки, Поти, Кобулети до Батуми.

Объекты и методы исследования

В ходе полевых исследований было отобрано более 50 образцов почвы. Каждый образец отбирался по принципу «конверта» из разных точек на территории вокзалов: в межрельсовом пространстве (центр), а также справа и слева на расстоянии 20 м от центра.

2.1. Подготовка образцов

Сохранение и транспортировка образцов для лабораторного анализа (подготовка и заполнение контейнеров, хранение, фильтрация образцов и т. д.) осуществлялись в соответствии с ГОСТ 31861-2012.

Из высушенного на воздухе образца удаляли механические примеси, корни растений и камешки. После разрыхления и просеивания через сито с диаметром ячейки 1 мм почву делили на четыре части и отбирали усредненную пробу. Для каждой станции определялись pH почвы и гумус.

2.2. Определение тяжелых металлов

1,0000 г образца помещали в фарфоровый тигель, предварительно доведенный до постоянной массы, и нагревали в муфеле при 450-500^{0}C в течение 1 часа. Затем охлаждали в эксикаторе, взвешивали и рассчитывали количество органических веществ по разнице масс.

Из тиглей образцы переносили в огнеупорные химические стаканы объемом 100 $см^3$, добавляли 30 мл смеси $3HCl + 1HNO_3$, выдерживали 15 минут, а затем высушивали до сухого остатка. Эту процедуру проводили дважды. Затем приливали 30 мл

10%-ной соляной кислоты, кипятили и переносили в мерные колбы объемом 50 см³, доверху заполнив той же кислотой. Содержание тяжелых металлов определяли на атомно-абсорбционном спектрофотометре AAnalyst 200 с пламенной атомизацией фирмы «Perkin Elmer» в соответствии со стандартом ISO 8288-1986.

Результаты и обсуждение

Ранее нами было показано [9], что глубина, с которой брали образцы почв, практически не влияет на содержание ТМ на всех вокзалах линии Тбилиси – Боржоми, поэтому зависимость содержания ТМ от глубины слоя в данной работе не изучалась - образцы отбирались только с поверхностного слоя толщиной 0-5 см. Полученные данные приведены ниже в таблице 1, согласно которым наиболее загрязненным участком является вокзал Поти, а наименее Абаша. По степени суммарной загрязненности тяжелыми металлами железнодорожные вокзалы располагаются в следующей последовательности (рис.1):

Поти→ Сенаки→Батуми→Зестафони→Кобулети→Самтредиа→Абаша

Таблица. 1.

Содержание ТМ на трех участках (в межрельсовом пространстве, на 20 м расстоянии справа и слева) вокзалов, мг/кг

Образец	Cu	Zn	Pb	Cd	Mn	Ni	Co
Самтредиа, слева	74.0	108.8	44.0	3.4	1890	254.2	0.0
Самтредиа, центр	142.6	164.0	87.4	2.6	8940	214.8	0.0
Самтредиа, справа	47.6	240.2	162.0	2.8	1786	125.4	0.0
Сенаки, слева	59.8	95.8	61.8	2.2	2136	186.2	0.0
Сенаки, центр	248.0	105.6	476.2	2.8	10000	220.8	0.0
Сенаки, справа	302.8	145.8	63.6	0.8	7236	189.4	0.0
Поти, слева	1064.0	339.6	49.2	0.1	1930	82.0	0.0
Поти, центр	257.4	144.7	149.3	1.5	6619	147.3	75.3
Поти, справа	42.2	70.7	19.7	1.4	5767	139.1	112.1
Батуми, слева	154.9	278.5	40.4	1.6	5700	338.4	71.3
Батуми, центр	115.2	193.6	63.8	1.9	6195	191.8	128.2
Батуми, справа	134.5	145.3	35.6	1.2	5497	223.7	81.8
Зестафони, слева	99.8	1075	54.1	2.1	5024	265.7	107.3
Зестафони, центр	59.8	72.4	27.8	2.1	6423	184.6	124.1
Зестафони, справа	65.3	95.7	29.1	2	5181	140.1	119
Кобулети, слева	83.3	84.3	68.5	2.6	1127	237.5	160.2
Кобулети, центр	161.6	110.3	49.9	2.5	1558	363.7	249.7
Кобулети, справа	152	131.6	52.3	0	1233	0	0
Абаша, слева	94.6	78	40.4	0	988	0	0
Абаша, центр	88.2	82.4	40	0	1024	0	0
Абаша, справа	86.4	83	35.1	0	1058	0	0
Геохимический фон[1]	**8.62–74.38**	**57.40–92.60**	**4.50–12.12**	**0.5**	**649–1631**	**27.76–56.74**	**12.4**
ПДК[2]	**55**	**150**	**100**	**5**	**1500**	**100**	**50**

[1] – рассчитан на основании [5];

[2] – даны на основании [10].

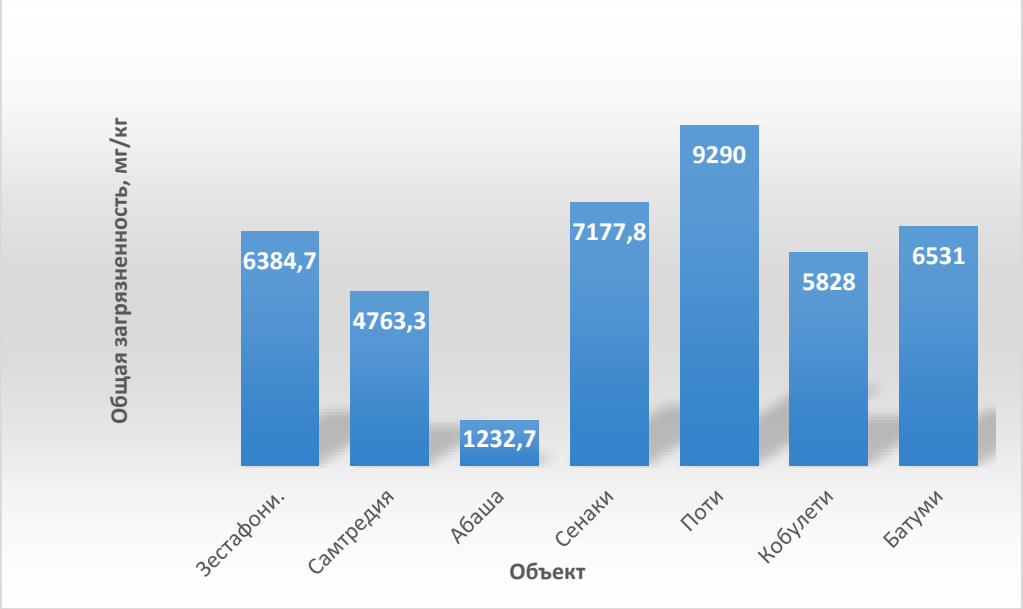


Рис. 1. Суммарная загрязненность тяжелыми металлами железнодорожной линии Зестафони-Батуми

Были рассчитаны коэффициенты концентрации загрязнителей и суммарный показатель загрязнения (табл.2) - последовательность по загрязнению изменилась существенным образом:

Сенаки → Зестафони → Батуми → Поти → Кобулети → Самтредиа → Абаша.

Таблица 2.

Рассчитанные коэффициенты концентраций ТМ для изученных станций

Вокзал	Kc (Cu)	Kc(Zn)	Kc(Pb)	Kc(Cd)	Kc(Mn)	Kc(Ni)	Kc(Co)	∑ Kc
Самтредиа	1.6	1.14	0.98	0.59	2.8	2.0	0	3.09
Сенаки	3.7	2.31	2	0.32	4.3	2.0	0	8.62
Поти	1.82	0.77	0.72	0.2	3.18	1.2	1.87	3.79
Батуми	2.45	1.37	0.47	0.32	3.87	2.5	1.87	6.86
Зестафони	1.36	2.76	0.37	0.4	3.69	2.0	2.33	6.88
Кобулети	2.4	0.71	0.57	0.34	0.87	2.0	2.73	3.62
Абаша	1.63	0.54	0.38	0	0.68	0.0	0	<0
ПДК*	**55**	**150**	**100**	**5**	**1500**	**100**	**50**	

Суммарный показатель химического загрязнения (Zc) характеризует степень химического загрязнения почв и грунтов обследуемых территорий вредными веществами различных классов опасности и определяется как сумма коэффициентов концентрации отдельных компонентов загрязнения по формуле:

Zc=Kc1+...+Kci+...+Kcn-(n-1),
[https://geoecology.nethouse.ru/page/146559],

где n - число определяемых компонентов,

Kci - коэффициент концентрации i-го загрязняющего компонента, равный кратности превышения содержания данного компонента над фоновым значением. В данном случае коэффициенты техногенной концентрации определяли ка частное от деления среднего значения величины загрязнения на ПДК, а не на фон. Для оценки уровня загрязнения почв рекомендуется рассчитать индексы Zc а также определить концентрацию ТМ на референтных участках [11], поскольку использование фоновой концентрации для сравнения вызывает много вопросов и опасений, хотя и применяется многими исследователями.

Почти все экспериментальные значения ТМ в почвах превышали новые, повышенные нормы ПДК [10]. При таком расчете коэффициентов концентрации и суммарного показателя химического загрязнения все изученные привокзальные участки являются незагрязненными.

И все же особого внимания заслуживает высокое содержание марганца почти во всех привокзальных почвах, что скорей всего указывает на природный характер источника. Наименее загрязненные станции – это Абаша и Кобулети. Состояние их почвенного покрова соответствует низкой степени загрязнения и поэтому низкому экологическому риску. Курортный Кобулети, а в особенности Абаша являются пассажирскими и загрязнение происходит в основном за счет трения колес о рельсы, токоприемника и контактной сети. Но, согласно полученным данным, Самтредиа также отличается низким суммарным показателем загрязнения, хотя она является узловой грузопассажирской станцией. Повышенная общая загрязненность отличает станции портовых городов Поти и Батуми и этот уровень загрязнения обусловлен в основном погрузочно-разгрузочными процессами.

Для некоторых, наиболее загрязненных привокзальных станций были определены подвижные формы элементов. Оказалось, что они составляют не более 2% от валового содержания элементов (рис.2). Медь практически не образует обменных соединений, Cd и Mn имеют повышенную подвижность и доступность растениям. Fe, Cu, Zn, Ni и Pb находятся в виде доступных сорбированных соединений [12], а повышение содержания гумуса сопровождается увеличением концентрации Pb, Cu, Zn и Cd. Авторы [11] полагают, что на накопление ТМ в почве в процессе эксплуатации железной дороги влияет широкий спектр факторов: интенсивность и скорость движения поездов; возраст железной дороги и степень ее эксплуатации; начальная тормозная скорость, тормозной путь; характер и объемы перевозимых грузов; погодные условия; рельеф; гранулометрический и химический состав почвы; растительный покров.

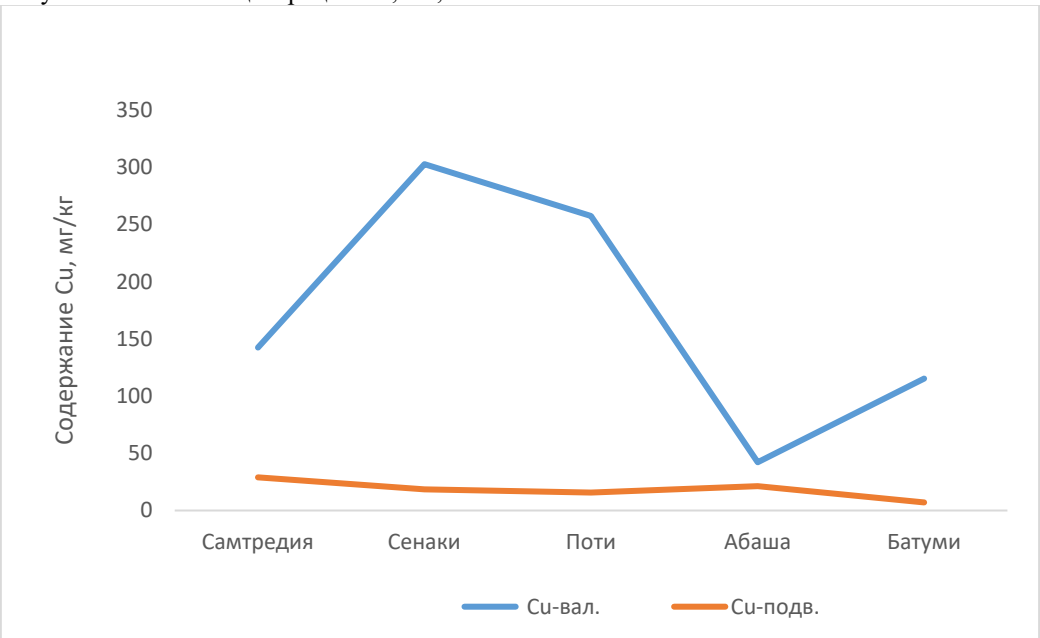


Рис.2. Соотношение валовой и подвижной форм меди

Заключение

Полученные экспериментальные факты еще раз свидетельствуют о том, что железнодорожный транспорт является источником эмиссии ТМ в почву, подтверждают необходимость и актуальность постоянного контроля содержания ТМ в почве объектов железнодорожной инфраструктуры.

Состояние почвенного покрова станции Абаша соответствует низкому экологическому риску и низкой степени загрязнения, поскольку станция является пассажирской и загрязнение происходит в основном за счет механического трения колес о рельсы, токоприемника и контактной сети. Загрязнение почвенного покрова станций Батуми и Поти характеризуется значительным потенциальным экологическим риском и очень высокой степенью загрязнения. Эти станции являются грузопассажирскими, и полученный уровень загрязнения обусловлен в основном погрузочно-разгрузочными процессами совместно с портами. Почвенный покров станций Кобулети и Самтредиа характеризуется средним потенциальным экологическим риском и умеренной степенью загрязнения. Хотя данная станция в основном используется для переформирования грузовых поездов, но из-за перевозки больших объемов насыпных рудных грузов в почву попадают ТМ.

Литература

1. https://nortest.pro/stati/pochva/zagryaznenie-pochv-i-gruntov-tyazhelymi-tallami.html.

2. N. Yu, YuN. Vodyanitskii, A. Vasil’ev A, T. Savichev A, A.N. Chashchin, The influence of technogenic and natural factors on the content of heavy metals in soils of the middle CisUrals region: the town of chusovoi and its suburbs, Eurasian Soil Sci. 43 (9) (2010) 1011-1021;

3. Yu N. Vodyanitskii, A.T. Savichev, A.A. Vasil’ev, et al., Contents of heav alkaline earth (Sr, Ba) and rare earth (Y, La, Ce) metals in technogenically contaminated soils, Eurasian Soil Sci. 43 (7) (2010) 822-832.

4. Yan, G., Mao, L., Liu, S., Mao, Y., Ye, H., Huang, T., Li, F., Chen, L., 2018. Enrichment and sources of trace metals in roadside soils in Shanghai, China: a case study of two urban/rural roads. Sci. Total Environ. 631–632, 942–950. https://doi.org/10.1016/j.scitotenv.2018.02.340).

5. G. Gambashidze, T. Urushadze, E. Blum, A. Mentler. Heavy metal in soils of West Georgia. Pochvovedenie, 2014, №8, 1-11;

6. Rasa Vaiskunaite, Vilma Jasiuniene. The analysis of heavy metal pollutants emitted by railway transport. 2020, Volume 35 Issue 2: 213–223;

7. Wiłkomirski, B.; Sudnik-Wójcikowska, B.; Galera, H.; Wierzbicka, M.; Malawska, M. 2011. Railway transportation as a serious source of organic and

inorganic pollution, Water, Air, & Soil Pollution: an International Journal of Environmental Pollution 218 (1–4): 333–345;

8. Akhalbedashvili L., Todradze G., Kvatashidze R., Loria N., Gagniashvili N., Janashvili N., Jalaghania S., Surguladze R., Ukleba, Brokishvili M. M. The mobile forms of heavy metals in soils of railway stations of Georgia. Sciences of Europe №155, (2024) 15-18;

9. Akhalbedashvili L., Kvatashidze R., Todradze G., Loria N., Janashvili N., Jalaghania S., Gagniashvili N. „The mobile forms of heavy metals in soils of railway stations of Georgia“, Sciences of Europe, Czech Republic. 2023, No 129, 48-52;

10. https://sakdrisiblog.wordpress.com/sakdrisige/rmg/hard-metals/;

11. A.V. Samarska, Y.V. Zelenko. Assesment of the railway influence on the heavy metal accumulation in soil. Екологія на транспорті. 2018, 6, 24-32 doi 10.15802/stp2018/140551;

12. Сиромля Т.И. Система форм соединений химических элементов в почвах и растениях юго-востока Западной Сибири. Автореферат. Новосибирск, 2019.

ECONOMIC SCIENCES

A STATISTICAL ASSESSMENT OF AZERBAIJAN'S EXPORT DYNAMICS WITH BELARUS, KAZAKHSTAN, KYRGYZSTAN: TRENDS, DETERMINANTS, AND ECONOMIC LINKAGES

Ibrahimkhalilova I.,
Asadzade G.,
Mirzazade R.
Academy of the State Customs Committee of Azerbaijan
DOI: 10.5281/zenodo.18083922

ABSTRACT

The aim of this research is to statistically analyze Azerbaijan's export operations with Belarus, Kyrgyzstan and Kazakhstan and to identify the evolving trade capacity between the countries over the period 2004–2024. Using descriptive statistics, covariance, and correlation analyses, the study examines how fluctuations in export volumes influence Azerbaijan's GDP and trade turnover. The results show that changes in export activity—driven by external factors such as global financial crises, pandemics, regional trade agreements, and currency volatility—have measurable effects on Azerbaijan's macroeconomic indicator.

The research also evaluates Azerbaijan's trade relations with Kazakhstan from 2005 to 2024, highlighting key determinants such as infrastructure development, the role of regional transport corridors including TRACECA and the Trans-Caspian Middle Corridor, and the increasing contribution of non-oil sectors such as agriculture, chemicals, and machinery. The findings indicate that export diversification, improved logistics connectivity, and institutional cooperation significantly enhance bilateral trade resilience.

Overall, the analysis demonstrates that exports, GDP, and turnover are closely interconnected: increases in one variable generally correspond to rises in the others. The study concludes that Azerbaijan's trade relations with Belarus and Kazakhstan, Kyrgyzstan are shaped by both structural economic reforms and external shocks, and that continued investment in non-oil sectors and transport infrastructure is essential for strengthening sustainable, multi-sectoral regional economic cooperation.

Keywords: Azerbaijan, Belarus, Kyrgyzstan, Kazakhstan, export, GDP, turnover, statistic analyses.

Introduction

Following the collapse of the Soviet Union, Azerbaijan began establishing independent economic relations with foreign countries, including members of the newly formed Commonwealth of Independent States (CIS). Within this regional framework, trade cooperation has played an essential role in shaping Azerbaijan's economic diplomacy and its strategy for regional integration. Although Azerbaijan has increasingly expanded its engagement with global markets, the CIS continues to be a major destination for its exports due to historical ties, logistical advantages, and geographic proximity.

Azerbaijan's trade relations with Kazakhstan, Kyrgyzstan, and Belarus are strongly influenced by their shared Soviet legacy, which has facilitated the movement of goods, services, and investments while contributing to regional economic stability. Statistical indicators show that Azerbaijan's exports to CIS countries have fluctuated significantly in both volume and structure over time. For instance, in 2013 Kazakhstan accounted for about 4.3% of Azerbaijan's total exports to the CIS, valued at roughly 64.2 million USD. This demonstrates Kazakhstan's position as a secondary yet gradually expanding market, particularly as Azerbaijan works to diversify its export base beyond hydrocarbons.

Azerbaijan's export composition to Kazakhstan has traditionally consisted of oil and oil-based products, as well as chemical materials and agricultural goods. However, recent policy measures aimed at fostering non-oil exports have increasingly diversified the product structure. Belarus has also emerged as one of Azerbaijan's significant post-Soviet trade partners, with bilateral relations strengthening considerably in recent years. As a CIS member, Belarus plays a crucial role in Azerbaijan's export strategy.

Azerbaijan's partnership with Kyrgyzstan, though smaller in scale, remains noteworthy. Both countries share similar post-Soviet economic development paths and have pursued greater cooperation in trade and investment. Kyrgyzstan's economy includes developing sectors such as agriculture, textiles, and mining—particularly gold. Despite having a modest trade volume compared to other partners, exports from Azerbaijan to Kyrgyzstan have grown steadily, increasing nearly elevenfold from 2.736 million USD in 1992 to 29.663 million USD in 2024.

Recent Publication

In recent decades, trade relations between Azerbaijan, Kazakhstan Kyrgyzistanand Belarus have attracted growing academic and policy interest due to their shared strategic location, economic potential, and complementary export structures.

he study of Azerbaijan's foreign trade and export operations, particularly in the context of post-Soviet economic integration, has been a focus of numerous scholarly works. Following the dissolution of the Soviet Union, Azerbaijan established independent economic relations with neighboring CIS countries, including Belarus, Kazakhstan, and Kyrgyzstan. This process has been influenced by historical, geopolitical, and logistical factors, with trade cooperation playing a key role in shaping the country's economic diplomacy and regional integration strategy (Dragneva & Wolczuk, 2017; Libman & Vinokurov, 2012).

A.D. Gronsky (2019) emphasizes that Belarus–Azerbaijan relations developed slowly initially due to limited mutual interest but gradually expanded through economic cooperation and political engagement. Shadunts (2021) further notes that industrial collaboration, particularly in manufacturing and logistics, has strengthened bilateral trade. Kukharska (2018) highlights the industrial and political foundations that underpin this cooperation, indicating that Belarus has emerged as a significant partner for Azerbaijan among post-Soviet states. Huseynova and Qurbanova (2025) argue that state policy, particularly in transport and logistics, is crucial in supporting these trade relations.

Kazakhstan represents a strategically important partner due to its geographical location and role in regional transport corridors, including TRACECA and the Trans-Caspian Middle Corridor. Sadri (2019) and Overland (2013) demonstrate that energy trade and infrastructure investments have been central to the development of Azerbaijan–Kazakhstan trade ties. Statistical analyses indicate that Azerbaijan's GDP and exports to Kazakhstan are positively correlated, reflecting the mutual reinforcement of economic growth and trade activity (Hüseynova, 2022; Huseynova, 2023). Pomfret (2019) emphasizes the diversification of exports into non-oil sectors, such as agricultural and machinery products, as a key driver of resilience in bilateral trade.

Trade with Kyrgyzstan, while smaller in volume compared to Belarus and Kazakhstan, has shown steady growth over time. Turgunbekova (2020) highlights that Kyrgyzstan's trade structure relies on agriculture, textiles, and mining exports. However, statistical studies (Guliyev & Huseynova, 2016; Huseynova, 2020) suggest that Azerbaijan's non-oil exports to Kyrgyzstan are volatile, reflecting sensitivity to external shocks, logistical constraints, and the dependence of Azerbaijan's domestic economy on oil and gas. The correlation between Azerbaijan's GDP and exports to Kyrgyzstan is moderate, indicating that economic growth alone is not sufficient to stabilize export flows in non-oil sectors.

The literature emphasizes the broader context of Eurasian integration and regional trade corridors. Vinokurov (2017) and Vickerman (2018) note that transport infrastructure, including pipelines, ports, and railways, is essential in facilitating trade and regional economic development. Dragneva and Wolczuk (2017) argue that the Eurasian Economic Union and other regional frameworks create structural opportunities for Azerbaijan to diversify its trade beyond hydrocarbons. Empirical studies using econometric models (Huseynova, 2023; Alirzayev & Huseynova, 2025) demonstrate that macroeconomic variables, such as GDP, exchange rates, and policy interventions, significantly influence trade dynamics.

Several studies highlight the importance of trade policy and macroeconomic management in shaping Azerbaijan's export performance. Sachs and Warner (1995), Edwards (1998), and Harrison (1996) emphasize the link between openness, productivity, and growth in developing economies. Recent analyses by the World Bank (2023) and the IMF (2024) underscore the impact of trade facilitation, infrastructure investment, and institutional efficiency on Azerbaijan's export operations. Similarly, the WTO (2023) trade policy review for Kazakhstan provides insights into regional trade regulations affecting Azerbaijan's bilateral commerce.

A growing body of literature employs econometric modeling to analyze Azerbaijan's trade patterns. Huseynova (2020, 2022, 2023) and Guliyev & Huseynova (2016) utilize correlation, covariance, and regression analyses to quantify the relationship between GDP, trade turnover, and export performance. These studies demonstrate that while exports to countries like Belarus and Kazakhstan show strong positive associations with Azerbaijan's GDP, exports to smaller partners like Kyrgyzstan are more volatile, reflecting non-oil trade vulnerabilities. Charkasov & Huseynova (2024) further explore factors influencing foreign direct investment, indicating that stable economic policies and infrastructure development are critical to maintaining trade growth.

The reviewed literature collectively indicates that Azerbaijan's trade relations with CIS countries are shaped by a combination of macroeconomic performance, infrastructure development, policy frameworks, and geopolitical factors. Exports to Belarus and Kazakhstan are more stable and closely linked to GDP growth, while trade with Kyrgyzstan exhibits higher volatility due to dependence on non-oil sectors and logistical challenges. The literature emphasizes the role of diversification, transport corridors, and institutional cooperation in enhancing trade resilience. These findings provide a strong foundation for the empirical analysis of Azerbaijan's export operations between 2004 and 2024.

Methodology: This research employs a quantitative approach to examine the dynamics of Azerbaijan's export operations and trade relations with Kazakhstan, Belarus, and Kyrgyzstan over the period 2004–2024. The methodological framework integrates descriptive statistics, correlation and covariance analysis, and regression modeling to evaluate the relationship between Azerbaijan's macroeconomic indicators—primarily GDP and total trade turnover—and the country's bilateral export performance.

Empirical analysis: The purpose of this section is to analyze the statistical dynamics of Azerbaijan's exports to Kazakhstan from a macroeconomic perspective, focusing on trade volume, structure, and the key determinants influencing export performance. The analysis forms part of a broader research project on Azerbaijan's trade with CIS countries, which also examines export relations with Kazakhstan, Belarus and Kyrgyzstan. By comparing these cases, the study aims to provide an integrated understanding of Azerbaijan's regional trade performance and its implications for economic diversification and sustainable growth.

Azerbaijan export operation to the Belarus is indicated in the Figure 1. Their international relationship has increased from 2004 to 2009. However, the financial crises cause reduction over the export process. This process hited its peak level thanks to economic and industry agreements which Azerbaijan send the agricultural products to Belarus in 2011.The importer country experienced the economic recession which currency sharply depreciated at the end of that year. So that, the

import of Belarus declined in 2012. In 2015, the price of oil fell and Azerbaijan dealing with devaluation twice. In the following years, the document signed between Azerbaijan and Belarus, which is contain new project about logistic relationship. Nevertheless, export to Belarus reduced due to COVID-19 in 2019. After the pandemic, trade has recovered again. The Russia and Ukranie conflic influence to Belarus, because Belarus is forced to think its trade policy with Azerbaijan again due to its western borders are closed.

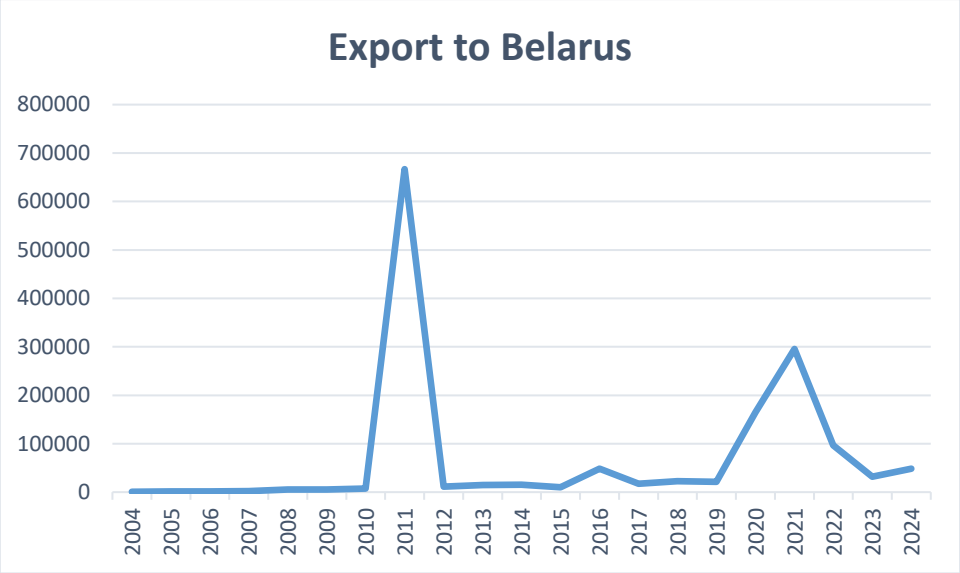


Figure 1: Azerbaijan export operation to the Belarus (2004-2024)

GDP of Azerbaijan is described in. Azerbaijan's GDP has grew between 2004 and 2007. However, the growth started to decline due to financial crisis in 2007. This affect recovered after 2009 and increased over the following years. Furthermore, the rate of GDP experienced plummet in 2015, which caused by devaluation. It rose slightly until Covid-19 in 2020. GDP has been affected by export process which has decreased. In the following years, the amount of GDP went up.

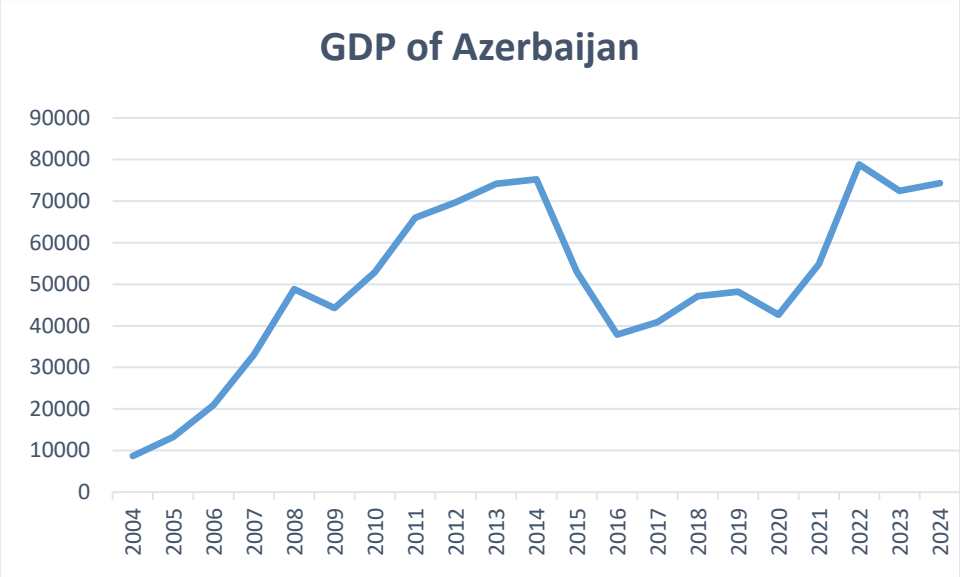


Figure 2: GDP of Azerbaijan(2004-2024)

These two graphs represent Azerbaijan's annual export operations to Kyrgyzstan and Azerbaijan's annual GDP from 2004 through 2024. With the completion of Baku– Tbilisi–Ceyhan pipeline, first oil plumped in 2005. In early-2000s

Azerbaijan's economy experience a growth duty the oil-gas export operations. While export operations to Kyrgyzstan approximately remain stable, Azerbaijan's GDP increase roughly from 8680 mln. USD up to 44297 mln. USD between 2004 and 2009. This reflects that in this time period Azerbaijan –Kyrgyzstan trade relations is weak. Because of the dependent on oil sector, after 2009 Azerbaijan's GDP still countinues to increase untill 2015. In other hand, Graph 1 demonstrates that export to Kyrgyzstan experiences syrges and plunges, even it reachs one of its peaks in 2010. This inconsistency between mowements if Azerbaijan's GDP and Azerbaijan's export operations to Kyrgyzstan reflects that Azerbaijan's trade operations with Kyrgyzstan has limited impact to Azerbaijan's overall economy. Since the export to Kyrgyzstan usually involves with non-oil sector, the effect is minor.

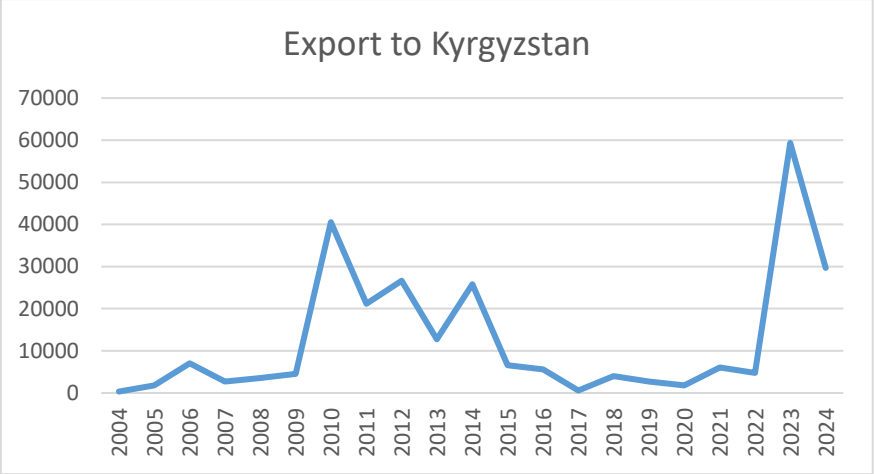


Figure 3: Azerbaijan export operation to the Kyrgyzstan (2004-2024)

Figure 4 demonstrates that The annual dynamics of Azerbaijan's exports to Kazakhstan between 2005 and 2024 reflect both external shocks and internal policy-driven factors. Rapid growth in 2006–2008, peaking in 2008, was fueled by high oil prices, expanding hydrocarbon output, and investment in transport and logistics infrastructure along the Caspian Sea corridor. The subsequent drop in 2009 coincided with the global financial crisis, which temporarily reduced demand for international trade. Exports gradually recovered between 2010 and 2013 due to macroeconomic stabilization, modest oil price recovery, and initial diversification efforts targeting non-oil sectors. Moderate growth between 2016 and 2019 reflects Azerbaijan's strategic shift toward non-oil products and operationalization of the Trans-Caspian International Transport Route (TITR). The temporary stagnation in 2020 was largely due to the COVID-19 pandemic, while a strong rebound in 2021–2024 resulted from digitalization of customs procedures, improved corridor efficiency, and targeted bilateral investment projects.

The combined trend analysis of GDP and exports to Kazakhstan shows that, from 2005 to 2024, Azerbaijan's GDP fluctuations, influenced by oil prices and economic policies, created a favorable but not directly proportional environment for exports to Kazakhstan. Trade growth was driven mainly by diversification into non-oil products—plastics, beverages, mechanical equipment, textiles, and agricultural goods—alongside infrastructure improvements and institutional cooperation. Overall, exports evolved from energy-dependent flows to a resilient, multi-sectoral pattern, highlighting that structural reforms, rather than GDP alone, are the key drivers of bilateral trade growth.

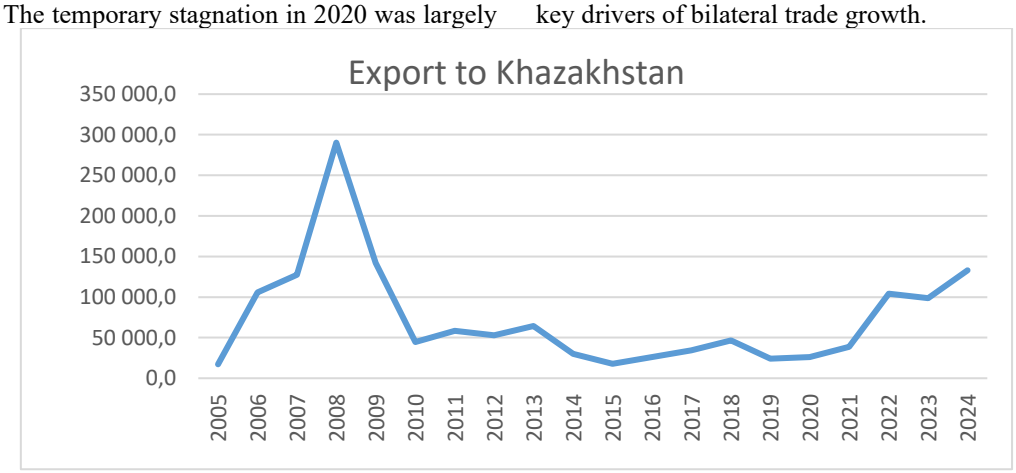


Figure 4: Azerbaijan export operations to Kazakhstan

Descriptive analysis uses statistical methods to summarize and organize characteristics of a dataset, making it easier to understand

Table 1.

Descriptive Statistics of Export to Belarus and GDP of Azerbaijan

Export to Belarus		*GDP*	
Mean	70902.70476	Mean	50339.55714
Standard Error	33476.21447	Standard Error	4456.85363
Median	15095.1	Median	48852.5
Mode	#N/A	Mode	#N/A
Standard Deviation	153407.2868	Standard Deviation	20423.86912
Sample Variance	23533795645	Sample Variance	417134429.9
Kurtosis	12.2119188	Kurtosis	-0.439277503
Skewness	3.3725904	Skewness	-0.451388411
Range	665981.4	Range	70127.1
Minimum	789.3	Minimum	8680.4
Maximum	666770.7	Maximum	78807.5
Sum	1488956.8	Sum	1057130.7
Count	21	Count	21
Largest(1)	666770.7	Largest(1)	78807.5
Smallest(1)	789.3	Smallest(1)	8680.4
Confidence Level(95.0%)	69830.15975	Confidence Level(95.0%)	9296.833762

This table shows the Descriptive Statistics of export to Belarus and GDP of Azerbaijan. In this graph gives the mean which means the avarage of all indicator. Standard devaition discribe that how the number far from mean. In export analyses, standard deviation higher than mean, so that, information is changable, it isn't stabil. However, in the GDP mean of data is less that standard deviation, therefore changes is less, have stability. Median divide the information into two parts. The median of export is 15095.1 and the median of GDP is 48852.5. Kurtosis is positive number in both, which their distribution is peakness. Skewness is also positive, it is higer than zero, so that distributions are rightside. Furthermore, in this graph 21 years are decribed. The higest number is 666770.7 for export in 2011 and 78807.5 for GDP in 2022. The lowest number in export and GDP is 789.3 and 8680.4 in and 2004 respectively. The total export is higer than total GDP of Azerbaijan over 21 years. It shows that Azerbaijan had open international trade with other countries.

Table 2

Descriptive Statistics of Export to Kyrgyzstan and GDP of Azerbaijan

Export to Kyrgyzstan		*GDP of Azerbaijan*	
Mean	12769,6	Mean	50339,55714
Standard Error	3402,62278	Standard Error	4456,85363
Median	5637,8	Median	48852,5
Mode	#N/A	Mode	#N/A
Standard Deviation	15592,77645	Standard Deviation	20423,86912
Sample Variance	243134677,5	Sample Variance	417134429,9
Kurtosis	2,860161176	Kurtosis	-0,439277503
Skewness	1,760131026	Skewness	-0,451388411
Range	58997,2	Range	70127,1
Minimum	341,1	Minimum	8680,4
Maximum	59338,3	Maximum	78807,5
Sum	268161,6	Sum	1057130,7
Count	21	Count	21
Largest(1)	59338,3	Largest(1)	78807,5
Smallest(1)	341,1	Smallest(1)	8680,4
Confidence Level(95.0%)	7097,746745	Confidence Level(95.0%)	9296,833762

Table 2 represent the descriptive statistics of Azerbaijan's GDP and Azerbaijan's export to Kyrgyzstan from 2004 to 2024.

This analysis examines Azerbaijan's GDP alongside its exports to Kyrgyzstan to understand overall economic performance and trade patterns.

The mean of Azerbaijan's annual GDP is analyzed as $50339,55714 mln. indicating average level of economic output, while this indicator is $12769,6 thousands in export side. In both sides mean is higher than median which demonstrates positive skew, meaning there are some years exports and GDP is higher than usual or expected value.

The standard error of Azerbaijan's GDP is more than the standard error of export to Kyrgyzstan which reflecting that economic output is less stable compared with export trade patterns.

The kurtosis of Azerbaijan's GDP is approximately is -0.439 and indicating that distribution is softness and slightly flat distribution. Negative kurtosis suggests that Azerbaijan's GDP did not experience sharp decreases and increases and moderate and stable economic condition.

The skewness of Azerbaijan's GDP is -0.451. It means that skewness is less than zero and distribution is in left side or left-skewed. This indicates that there were a few years less than average GDP and reduced overall average and reflects moderate and stable economy.

Table 3

Descriptive Statistics of Export to Kazakhstan and Turnover of trade between Azerbaijan and Kazakhstan

Export to Kazakhstan		*Turnover of trade between Azerbaijan and Kazakhstan*	
Mean	74108,05	Mean	275696,495
Standard Error	14591,5198	Standard Error	30982,41415
Median	49735	Median	241901,8
Mode	#N/A	Mode	#N/A
Standard Deviation	65255,26036	Standard Deviation	138557,5683
Sample Variance	4258249004	Sample Variance	19198199730
Kurtosis	5,517185605	Kurtosis	-0,075442118
Skewness	2,079300582	Skewness	0,747472278
Range	273082,4	Range	485910,1
Minimum	17166,1	Minimum	112511,2
Maximum	290248,5	Maximum	598421,3
Sum	1482161	Sum	5513929,9
Count	20	Count	20
Largest(1)	290248,5	Largest(1)	598421,3
Smallest(1)	17166,1	Smallest(1)	112511,2
Confidence Level(95.0%)	30540,40194	Confidence Level(95.0%)	64846,93808

All figures for both export values and trade turnover are reported in thousands of USD. The descriptive indicators reveal clear structural differences between Azerbaijan's export volumes to Kazakhstan and the overall bilateral trade turnover. The mean values show that trade turnover (≈ 275,696 USD) is almost four times higher than direct exports (≈ 74,108 USD), confirming Kazakhstan's strong significance in reciprocal trade flows. The minimum–maximum values and range indicate that turnover (range ≈ 485,910 USD) fluctuates more widely than exports (range ≈ 273,082 USD), reflecting greater variability driven by Kazakhstan's exports to Azerbaijan. Distributional indicators also highlight important contrasts: both datasets exhibit positive skewness, yet exports (skewness ≈ 2.08) have more pronounced right-tailed asymmetry, meaning some years experience unusually sharp export increases. Regarding kurtosis, export data show a leptokurtic structure (≈ 5.51), indicating extreme peaks and heavy tails, while trade turnover has slightly negative kurtosis (≈ –0.07), reflecting a flatter and softer distribution with fewer extreme deviations.

Result of the dispersion analysis about Kazakhstan, Belarus, Kyrgyzstan between the Azerbaijan GDP.

Accordingly, dispersion for Azerbaijan exports to Kazakhstan equals $(65{,}255.26)^2 \approx 4.26 \times 10^9$, while dispersion for trade turnover equals $(138{,}557.57)^2 \approx 1.92 \times 10^{10}$. These results confirm that turnover exhibits substantially higher variance, indicating broader fluctuations around its mean compared to the more concentrated export values.

The dispersion values calculated for Azerbaijan's exports to Belarus and for Azerbaijan's GDP illustrate the degree of variability in each indicator over the examined period.

Variance of Exports to Belarus:

$\sigma^2_{\text{Export}} = 23{,}533{,}795{,}643.34$ thousand USD

This extremely high variance indicates that Azerbaijan's exports to Belarus have been **highly unstable and volatile** during the analyzed years. The large fluctuations suggest that export volumes experienced significant increases and decreases rather than following a steady trend. Such variability can be associated with:

- Changes in trade agreements or political relations
- External shocks (economic crises, pandemics, sanctions)
- Shifts in demand for Azerbaijan's exported goods
- Variations in the composition of exported products (oil vs. non-oil goods)

The high dispersion reflects an export pattern that lacks consistency, highlighting sensitivity to external and internal economic conditions.

Variance of GDP:

$\sigma^2_{\text{GDP}} = 417{,}134{,}429.83$ thousand USD

Compared with export variance, GDP shows **much lower dispersion**, indicating that Azerbaijan's overall economic output is relatively **stable**. Although GDP grows or contracts over time, the magnitude of its fluctuations is far smaller than the fluctuations observed in exports to Belarus. This is expected because:

- GDP is a broad macroeconomic indicator influenced by many sectors
- Large economies typically show smoother long-term growth patterns
- Temporary shocks in specific export markets do not immediately cause extreme changes in GDP

The comparison between the two variances shows that:

- **Exports to Belarus are highly volatile**, experiencing large jumps and declines.
- **GDP is considerably more stable**, showing moderate and predictable changes over time.

This implies that while Azerbaijan's bilateral trade with Belarus is strongly affected by external conditions and sector-specific dynamics, the country's overall economy remains more robust and less sensitive to fluctuations in this single export market.

Table 4

Correlation Analysis of Azerbaijan exports operation to Belarus and GDP of Azerbaijan

	Export to Belarus	*GDP of Azerbaijan*
Export to Belarus	1	
GDP of Azerbaijan	0.23951	1

Based on studies, correlation coefficient equal 1 during given years, it means that have stong relations between the variables. On the other hand, relations between variables is 0.23951, it shows that they have weak positive relations.

Table 5

Correlation Analysis of Azerbaijan exports operation to Kazakhstan and Turnover of trade between Azerbaijan and Kazakhstan

	Export to Kazakhstan	*Turnover of trade between Azerbaijan and Kazakhstan*
Export to Kazakhstan	1	
Turnover of trade	0,629523359	1

The correlation coefficient between Azerbaijan's exports to Kazakhstan and the total trade turnover equals r = 0.6295, indicating a moderately strong positive relationship. This means that increases in Azerbaijani exports are generally associated with corresponding increases in overall bilateral trade. Although the correlation is not perfect, suggesting that turnover is also influenced by factors such as Kazakhstan's exports to Azerbaijan, logistics costs, and regional economic conditions, the result nonetheless confirms that export growth is a key driver of increasing bilateral trade volumes. The positive correlation between Azerbaijan's exports to Kazakhstan and the overall trade turnover can be partially explained by the structural factors shaping bilateral economic relations. Over the years, both countries have strengthened cooperation through transport and logistics infrastructure, including oil pipelines, railway lines, and seaports, which significantly facilitate the movement of goods.

Table 6

Correlation Analysis of Azerbaijan exports operation to Kyrgyzstan and GDP of Azerbaijan

	Export to Kyrgyzstan	*GDP*
Export to Kyrgyzstan	1	
GDP	0,568459422	1

Table 6 represents correlation coefficient between GDP and export. Correlation coefficient measures degree of relation between 2 indicators. As provided in table 1.4, correlation coefficient is approximately 0.56 ($0.3 < 0.56 < 0.7$) and this variable indicates that there is middle relation between GDP and Export. This indicator shows GDP and Export move in the same direction, but they are not perfect. There is inconsistency between GDP and export as a result of external factors such as Azerbaijan's dependence on oil-sector, changing Kyrgyzstan demand, trade policies etc.

Conclusion: The economic, political, and cultural relationship between Azerbaijan and Kazakhstan has

developed into a strong and strategically important partnership for the wider region. Statistical and correlation analyses indicate that Azerbaijan's trade with Kazakhstan has a meaningful connection to its GDP, demonstrating the mutually supportive relationship between economic growth and export performance. Over the past twenty years, the structure and volume of exports have been shaped by several factors, including the expansion of transport and logistics infrastructure—such as ports, railways, pipelines, the Baku Grain Terminal, and the Aktau Logistics Center—alongside efforts to diversify export products beyond traditional hydrocarbons. These developments, combined with changes in global market conditions and the growing use of alternative transport routes such as the Middle Corridor and TRACECA, have all contributed to shifts in trade dynamics.

Political stability, continuous high-level dialogue, and targeted investment in energy, transport, and industrial sectors have further strengthened economic integration between the two countries. Regional initiatives—from the BTC and Trans-Caspian pipelines to joint industrial projects—have played a significant role in shaping bilateral trade and ensuring smoother cross-border flows of goods. Additionally, cultural and historical ties, reinforced through cooperation under organizations such as the Turkic Council and TURKSOY, have enhanced mutual trust and created favorable conditions for long-term partnership.

In the current geopolitical landscape, Azerbaijan–Kazakhstan relations play a key role in improving regional connectivity, providing alternative trade and energy corridors that reduce dependency on traditional routes and enhance economic resilience. The involvement of regional powers such as Turkey and China further underscores the importance of this partnership, as it contributes to stability, energy security, and efficient transport networks across Eurasia. Overall, the cooperation between Azerbaijan and Kazakhstan highlights how coordinated action across economic, infrastructural, political, and cultural spheres—supported by modern logistics systems—can advance sustainable development, deepen regional integration, and create new strategic opportunities.

Evidence from export operations also shows notable fluctuations in Azerbaijan's exports to Belarus between 2004 and 2024. These variations were linked to external factors such as economic crises, trade policies, and global disruptions. Correlation and covariance findings confirm strong positive relationships between exports, GDP, and trade turnover, indicating that these indicators generally move in the same direction; however, the analysis also reveals that additional economic factors must be considered when studying export performance.

Similarly, the research on Azerbaijan–Kyrgyzstan trade relations from 2004 to 2024, based on descriptive statistics, covariance, correlation coefficients, and regression analysis, shows that while Azerbaijan's GDP followed a relatively stable upward trend, exports to Kyrgyzstan fluctuated significantly. These sharp fluctuations stem from Azerbaijan's heavy reliance on the oil-gas sector and the predominantly non-oil nature of exports to Kyrgyzstan. The results provide meaningful insights for policymakers and businesses seeking to strengthen bilateral trade, particularly by improving transport infrastructure, reducing trade costs, and broadening the range of exported goods. Future studies may expand this analysis by including additional Asian countries to explore regional trade patterns more comprehensively.

Discussion. The overall analysis of Azerbaijan's bilateral trade relations with Kazakhstan, Belarus, and Kyrgyzstan from 2004 to 2024 reveals important dynamics that extend beyond simple trade flows and reflect deeper economic, structural, and geopolitical factors. The strong positive correlations observed between Azerbaijan's GDP, total trade turnover, and export performance—particularly in the case of Kazakhstan and Belarus—indicate that economic growth and export activity tend to reinforce one another. This finding supports the broader argument that Azerbaijan's external trade is closely integrated with its internal macroeconomic performance, especially during periods of stable oil revenues and expanding logistics infrastructure.

In the case of Kazakhstan, statistical and correlation results suggest a tight connection between export growth and Azerbaijan's GDP. This relationship is strengthened by long-term political cooperation, shared cultural ties, and major regional projects such as the Middle Corridor, Trans-Caspian routes, and joint logistics facilities. These structural factors have not only facilitated smoother trade flows but also created synergistic effects between economic and political spheres. Infrastructure investments—such as the Baku Grain Terminal, ports, and rail links—have enhanced Azerbaijan's competitiveness and contributed to the steady evolution of its export structure.

By contrast, exports to Kyrgyzstan exhibit a more volatile pattern. Although Azerbaijan's GDP followed a generally upward trajectory, exports to Kyrgyzstan fluctuated sharply, reflecting sensitivity to non-oil market conditions, changing demand, and transport-related constraints. The divergence between GDP growth and export trends suggests that Azerbaijan's non-oil trade with Kyrgyzstan is less stable and more vulnerable to external shocks. Statistical indicators such as high variability, skewness, and fluctuations in dispersion measures further highlight this inconsistency. The results imply that economic growth in Azerbaijan—driven largely by the oil and gas sector—does not automatically translate into stable export growth toward Kyrgyzstan, where the trade basket mainly involves non-oil goods.

The findings from the Belarus export analysis, which showed periods of increase and decline, also underline the importance of external conditions such as regional demand shifts, political developments, and evolving transport corridors. While covariance and correlation measures indicate a generally positive association between GDP, turnover, and exports, the existence of fluctuations emphasizes the need to consider additional variables—such as commodity prices, logistics routes, trade policies, and supply chain disruptions—when interpreting export dynamics.

Across all three bilateral relationships, the research suggests that infrastructure, diversification of

export goods, and geopolitical connectivity play decisive roles in shaping Azerbaijan's export performance. Countries with strong political alignment, shared cultural platforms, and integrated transport corridors (such as Kazakhstan) display more stable and predictable trade growth. Meanwhile, relations with partners where transport costs are higher, product structures differ, or economic complementarities are weaker (such as Kyrgyzstan) tend to show greater volatility.

Overall, these results demonstrate that while Azerbaijan's macroeconomic indicators form an important baseline for understanding export trends, they are not sufficient on their own. Export performance must be analyzed through a multidimensional lens that includes logistics capacity, regional cooperation frameworks, non-oil sector development, and the strategic behavior of partner countries. Future research can provide deeper insights by incorporating **additional Central Asian economies, examining sector-specific export categories, or integrating time-series forecasting models to predict future trade patterns.**

References

1. A.D. Gronsky, Belarus-Azerbaijan Relations (2005-2018): between Economy and Search for political Support, 2019

2. Dragneva, R., & Wolczuk, K. (2017). *The Eurasian Economic Union: Deals, rules, and the exercise of power*. London: Chatham House.

3. Edwards, S. (1998). Openness, productivity, and growth: What do we really know? *Economic Journal*, 108(447), 383–398.

4. Harrison, A. (1996). Openness and growth: A time-series, cross-country analysis for developing countries. *Journal of Development Economics*, 48(2), 419–447.

5. Hüseynova, S. (2022). THE ECONOMETRIC ANALYSIS OF THE INTERRELATION BETWEEN THE INCLUSIVE INDICATORS OF AZERBAIJAN, RUSSIA AND KAZAKHSTAN. *TURAN-SAM*, *14*(56), 118-124.

6. Huseynova, S. (2023). COINTEGRATION ANALYSIS OF ECONOMIC GROWTH PARAMETERS BETWEEN RUSSIA AND AZERBAIJAN. *Sciences of Europe*, (110), 26-31.

7. Guliyev, R. R., & Huseynova, S. M. (2016). Research on Azerbaijan's import and annual GDP correlation based on econometric models in the frame of joining WTO. *Journal of Contemporary Applied Mathematics-ISSN: 2222-5498*, *6*(1

8. Shadunts, M. (2021). Industrial cooperation between Belarus and Azerbaijan: Trends and perspectives. *Eurasian Economic Review*, 11(4), 623–640.

9. Turgunbekova, A. (2020). Kyrgyzstan's foreign trade structure: Trends and challenges. *Central Asia Policy Review*, 8(2), 89–104.

10. Vickerman, R. (2018). Can transport infrastructure promote regional economic development? *Transport Policy*, 69, 1–7.

11. Huseynova, S. (2020). THE ECONOMETRIC ANALYSIS OF THE INTERRELATION BETWEEN THE GDP OF AZERBAIJAN, RUSSIA, BELARUS AND KAZAKHSTAN. *InterConf,(37). вилучено із https://ojs. ukrlogos. in. ua/index. php/interconf/article/view/6818*.

12. Alirzayev, E., & Huseynova, S. (2025). Empirical Evidence Of J-Curve Effect And Marshall Lerner Condition: Case Of Azerbaijan. *The Scientific-Analytical Journal" Economic Reforms"*, *2025*(1), 40-56.

13. Kukharska, N. (2018). Belarus–Azerbaijan economic cooperation: Industrial and political foundations. *Journal of Post-Soviet Studies*, 4(1), 33–47.

14. Libman, A., & Vinokurov, E. (2012). *Holding-together regionalism: Twenty years of post-Soviet integration*. London: Palgrave Macmillan.

15. Pomfret, R. (2019). *The Central Asian economies in the twenty-first century: Paving a new silk road*. Princeton University Press.

16. Sadri, H. (2019). Azerbaijan–Kazakhstan relations and the geopolitics of Eurasian energy corridors. *Journal of Eurasian Studies*, 10(1), 1–12.

17. Sachs, J., & Warner, A. (1995). Economic reform and the process of global integration. *Brookings Papers on Economic Activity*, 1995(1), 1–118.

18. Huseynova S., & Qurbanova N. (2025). THE ROLE OF STATE POLICY IN REGULATING TRANSPORT AND LOGISTICS SERVICES IN THE DEVELOPMENT OF FOREIGN TRADE. Sciences of Europe, (162), 15-17.

19. Huseynova, S. M., & Hajizada, T. J. (2024). Analysis of the Stability of the Banking Sector of Azerbaijan in Conditions of Economic Crisıs Based on the Econometric Model. *Статистика и экономика*, *21*(2), 35-49.

20. Charkasov, M., & Huseynova, S. (2024). Azerbaycan'da Doğrudan Yabancı Yatırım Girişlerine Etki Eden Faktörlerin ARDL Sınır Testi Yaklaşımı ile Araştırılması.

21. The State Statistical Committee of Azerbaijan. www.stat.gov.az

22. Overland, I. (2013). Caspian Energy Politics: Azerbaijan, Kazakhstan and Turkmenistan. Routledge.

23. Pomfret, R. (2019). The Central Asian Economies in the Twenty-First Century. Oxford University Press.

24. World Bank. (2023). Trade Expansion through Market Connection: Central Asian Markets and Caucasus Integration.

25. World Trade Organization. (2023). Trade Policy Review – Kazakhstan. Geneva: WTO Secretariat.

26. International Monetary Fund. (2024). Republic of Azerbaijan: Recent Economic Developments. Washington D.C.

STATISTICAL EVALUATION OF TRADE TURNOVER BETWEEN AZERBAIJAN AND TÜRKIYE

Nesibov K.
Academy of State Customs Committee of the Republic of Azerbaijan
DOI: 10.5281/zenodo.18084002

ABSTRACT

This research paper provides a comprehensive statistical analysis of bilateral trade turnover between Azerbaijan and Türkiye (from 2005 to 2024). The primary objective is to identify long-term trends, quantify volatility, and diagnose the principal economic and geopolitical determinants driving the evolution of this strategic partnership. Employing descriptive statistics, time-series analysis, and correlation measures, the study evaluates trade dynamics in conjunction with the nominal GDP trajectories of both nations.

The findings reveal a pattern of significant long-term growth punctuated by pronounced volatility. Key inflection points are directly linked to major external events and infrastructure projects: trade surged following the operational launch of the **Baku-Tbilisi-Ceyhan (BTC) pipeline**, contracted sharply during the **2008-2009 Global Financial Crisis**, and reached historic peaks driven by the **Trans-Anatolian Natural Gas Pipeline (TANAP)** and the **post-2022 geopolitical realignment**, before correcting in 2024 with the normalization of global energy prices. Statistical analysis confirms a strong positive correlation between trade turnover and GDP for Türkiye (0.676) and a moderate correlation for Azerbaijan (0.521), underscoring trade's integral role in both economies.

Additionally, the study also concludes that while energy mega-projects have successfully scaled the economic relationship and cemented a deep strategic interdependence, they have also resulted in an asymmetric trade structure heavily concentrated in hydrocarbons. This concentration leaves bilateral trade highly susceptible to global commodity price fluctuations. The paper emphasises the importance of a deliberate policy and research focus on economic diversification and non-energy trade sectors to establish a more resilient and balanced bilateral trade framework for the future.

Keywords: Turkey, trade, relation, development, export.

Introduction

Turkey and Azerbaijan not only share strong political and cultural relations but also a thriving economic partnership that has developed at an increasing rate year after year. Trade lies at the core of this alliance, reflecting the two countries' increased economic strength and commitment to regional association. It is beneficial to ascertain how trade turnover between Turkey and Azerbaijan has developed over the years in order to reveal the milestones and challenges in their economic partnership.

In the last few years, bilateral trade between the two nations has increased gradually, driven by collaboration in energy, transportation, and building projects. Initiatives such as the Baku–Tbilisi–Ceyhan pipeline and other free trade arrangements have opened up new channels for the two. Nevertheless, global economic trends, commodity price fluctuations, and political factors sometimes influenced the volume and path of trade.

Literature Reeview

The literature on international trade and bilateral economic relations provides a strong theoretical and empirical foundation for analyzing trade turnover between Azerbaijan and Türkiye. Classical theories of international trade, beginning with comparative advantage (Ricardo, 1817) and later formalized through the Heckscher–Ohlin framework (Heckscher, 1919; Ohlin, 1933), explain trade patterns based on differences in factor endowments and production structures. These theories are particularly relevant for understanding Azerbaijan's specialization in energy and resource-based exports and Türkiye's diversified manufacturing and industrial exports.

Modern trade theory extends classical approaches by incorporating economies of scale, imperfect competition, and product differentiation. Krugman (1980) and Helpman and Krugman (1985) emphasize that trade between economically integrated and geographically proximate countries is increasingly driven by scale effects and intra-industry trade rather than factor endowments alone. This perspective is important for explaining the steady expansion of Azerbaijan–Türkiye trade relations since the mid-2000s.

Empirical trade analysis has been significantly advanced through quantitative indicators and econometric models. Balassa's (1965) Revealed Comparative Advantage (RCA) index remains one of the most widely used tools for assessing trade competitiveness and specialization patterns. Building on this framework, Akay (2023) applies an RCA-based approach to Türkiye–Azerbaijan economic relations, demonstrating sectoral complementarities and highlighting the evolving nature of bilateral trade advantages.

The gravity model of trade has become a dominant empirical framework for analyzing bilateral trade flows. Tinbergen's (1962) early work laid the foundation, while Anderson and van Wincoop (2003) refined the model by addressing multilateral resistance factors. Further empirical contributions by Feenstra (2004) and Helpman, Melitz, and Rubinstein (2008) emphasize firm heterogeneity and trade participation decisions, providing deeper insights into the volume and structure of trade flows between countries. These models are particularly relevant for analyzing Azerbaijan–Türkiye trade turnover over a long time horizon.

Several studies focus directly on Azerbaijan's trade performance and macroeconomic dynamics. Huseynova (2014) examines Azerbaijan's challenges related to WTO accession, highlighting structural and institutional constraints affecting foreign trade integration. Alirzayev and Huseynova (2025) investigate the J-curve effect and Marshall–Lerner condition for Azerbaijan, providing empirical evidence on how exchange

rate dynamics influence trade balance adjustments. These findings are important for interpreting fluctuations in bilateral trade turnover.

Macroeconometric approaches are also widely used in related literature. Charkasov and Huseynova (2024) apply the ARDL bounds testing approach to analyze foreign direct investment inflows in Azerbaijan, demonstrating the usefulness of long-run and short-run dynamic modeling. Similar econometric rigor is observed in studies by Huseynova and Hajizada (2024), which assess banking sector stability under crisis conditions, underscoring the broader macroeconomic environment in which trade relations evolve.

Regional and financial integration perspectives further enrich the literature. Huseynova and Charkasov (2024) analyze long-run relationships between Türkiye and Shanghai Cooperation Organization stock markets, indicating increasing economic and financial interconnectedness. Such findings indirectly support the notion that deepening economic ties extend beyond trade and influence overall bilateral economic relations.

Methodology.

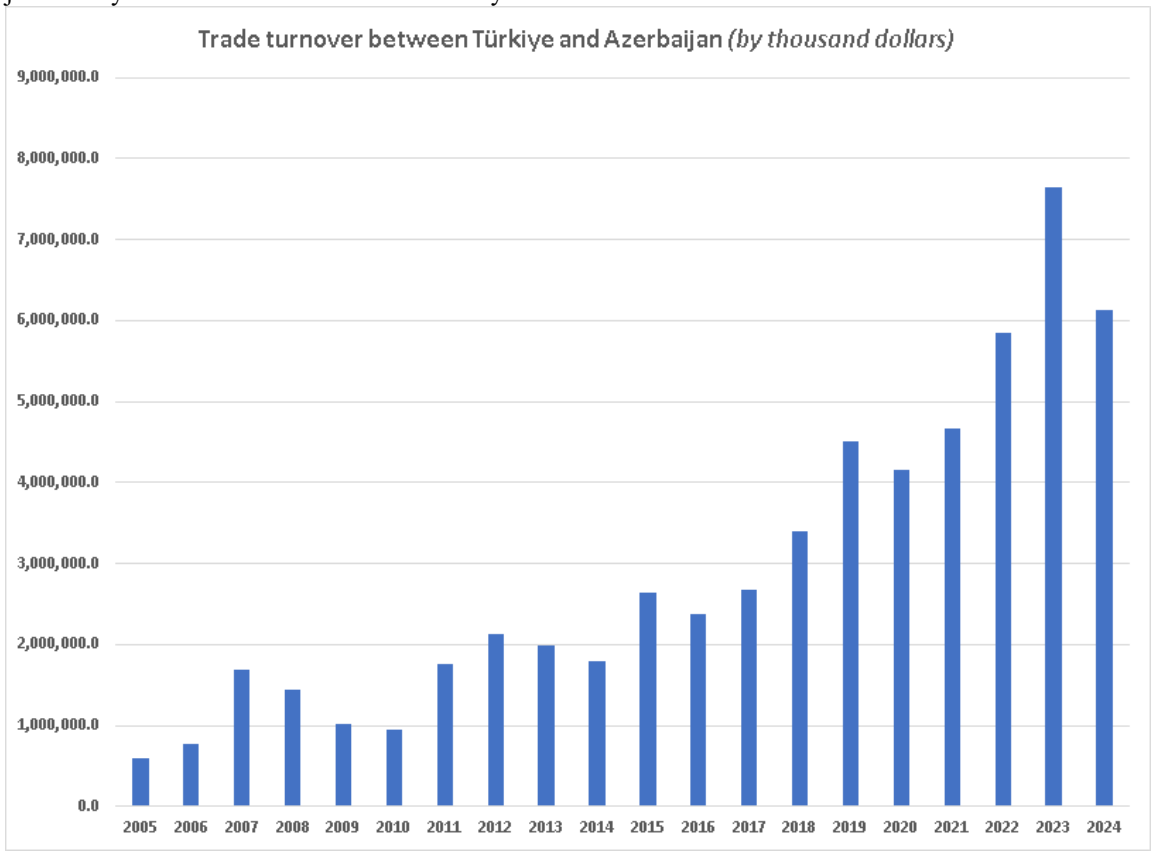
Descriptive statistics, including mean, median, growth rates, and standard deviation, are used to summarize the general characteristics of bilateral trade turnover. Trend analysis and index numbers are applied to identify long-term developments and periods of acceleration or decline in trade relations. Annual growth rates of exports, imports, and total trade turnover are calculated to examine the dynamics of bilateral trade. Structural changes in trade composition are assessed through comparative analysis across sub-periods, allowing the identification of key turning points in Azerbaijan–Türkiye trade relations. Correlation analysis is used to examine the relationship between trade turnover and selected macroeconomic variables.

Statistical analyses and discussion:

Institutional and statistical sources play a crucial role in empirical trade studies. Official data from the State Statistical Committee of the Republic of Azerbaijan, the Turkish Statistical Institute (TURKSTAT), the World Bank, WTO, IMF, and UNCTAD provide consistent and internationally comparable trade statistics, forming the empirical backbone of most bilateral trade analyses.

Overall, the existing literature demonstrates that Azerbaijan–Türkiye trade relations are shaped by a combination of classical comparative advantages, modern trade dynamics, macroeconomic conditions, and institutional factors. However, despite a growing body of empirical research, there remains a need for comprehensive long-term statistical evaluations that integrate trade theory with up-to-date bilateral data covering extended periods such as 2005–2024. This study seeks to contribute to the literature by addressing this gap through a systematic statistical evaluation of trade turnover between Azerbaijan and Türkiye.

In this paper, a more detailed look at Turkish-Azerbaijani trade turnover is undertaken through statistical research. By observing export, import, and overall trade tendencies, it attempts to determine the most significant tendencies, indicate the priorities of development sectors, and evaluate determinants that impact this key bilateral relationship. Lastly, the paper attempts to paint a clearer picture of how trade between these two countries has evolved and what this means in terms of future economic collaboration.



Graph 1. Trade turnover between turkey and Azerbaijan

The provided graph illustrates the dynamic trajectory of total bilateral trade turnover between Turkey and Azerbaijan over a two-decade span, specifically from 2005 to 2024.

The overall trend reveals a pattern of significant long-term growth punctuated by periods of volatility. Trade commenced at a modest level in 2005 (approximately $500 billion) and embarked on a steep, nearly exponential growth trajectory until approximately 2013-2014, where it appears to have reached a first major peak.

A notable sharp decline is observed around 2015-2016, likely correlating with the global collapse of hydrocarbon prices, which significantly impacted Azerbaijan's export revenues. Following this correction, trade entered a phase of recovery and consolidation from 2017 onwards, establishing a new, higher baseline.

The most striking feature of the graph is the unprecedented surge beginning in 2020-2021, which culminates in a historic peak in 2023. This dramatic increase can be attributed to a confluence of geopolitical and economic factors following the post-pandemic recovery and the 2022 regional geopolitical shifts, which reconfigured trade and logistics routes in the South Caucasus.

Preliminary data for 2023-2024 suggests a partial correction or stabilisation from the 2022 peak, indicating a potential market adjustment or a normalisation of trade flows after the exceptional circumstances.

Table 1.

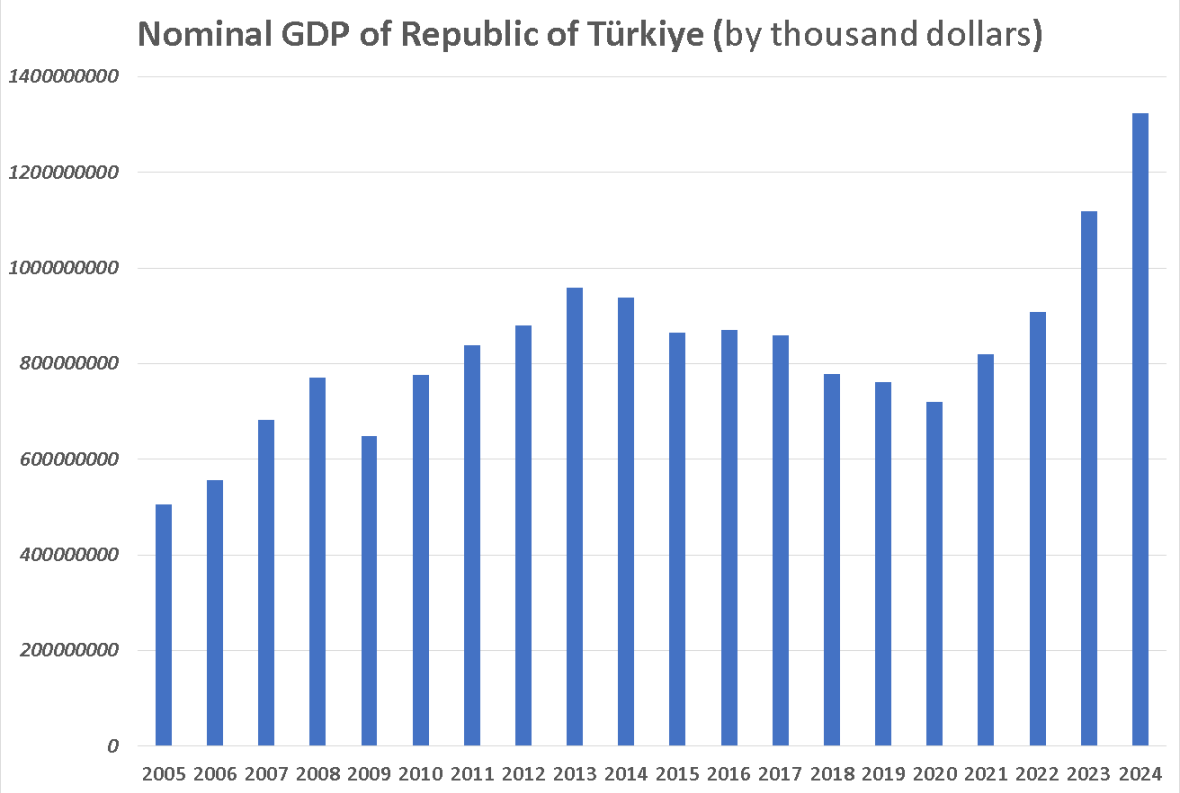
Descriptive statistics of Trade turnover between Türkiye and Azerbaijan

Trade turnover between Türkiye and Azerbaijan	
Mean	2906602.15
Standard Error	442656.7841
Median	2243835.7
Mode	#N/A
Standard Deviation	1979621.32
Sample Variance	3.9189E+12
Kurtosis	0.205531012
Skewness	0.989621392
Range	7061638.6
Minimum	588960.9
Maximum	7650599.5
Sum	58132043
Count	20
Largest (1)	7650599.5
Smallest (1)	588960.9
Confidence Level (95.0%)	926491.297

Suggesting that the distribution is influenced by several relatively high observations. This is further supported by the positive skewness coefficient (0.989), which demonstrates a right-skewed distribution driven by years with exceptionally high trade flows. The standard deviation (1,979,621) and the range (7,061,638) reveal substantial variability in trade turnover across years, indicating that the bilateral trade relationship has experienced significant fluctuations rather than stable growth. The kurtosis value (0.205) is close to zero, implying that the distribution does not significantly deviate from normality in terms of its peak and tails.

The minimum and maximum values, USD 588,960 and USD 7,650,599, respectively, further illustrate the large disparity between the lowest and highest recorded trade volumes. Additionally, the 95% confidence interval of ±926,491 around the mean demonstrates a moderate level of uncertainty with respect to the true population mean. Overall, the descriptive statistics highlight a dynamic and highly variable trade pattern between Türkiye and Azerbaijan over the period under review.

In the next discussion, we will undertake an in-depth examination of the Gross Domestic Product (GDP) of both Azerbaijan and Türkiye. Our primary objective is to uncover the underlying scientific and economic factors that have influenced the fluctuations and trends observed in GDP over the years. We will start by analysing historical data, looking at how various elements such as government policies, global economic conditions, and resource availability have played a role in shaping the economic performance of these two nations. Additionally, we will explore the impacts of significant events, such as geopolitical tensions, trade agreements, and shifts in domestic markets, which have contributed to the observed changes in GDP. By employing statistical methods and economic theory, we aim to provide a comprehensive understanding of the nuances behind the economic growth or contractions experienced in Azerbaijan and Türkiye.



Graph 2. Nominal GDP of republic of Turkey

Table 2.

Nominal GDP of republic of Azerbaijan

Table 3.

Descriptive statistics of the nominal GDP of Azerbaijan by years

Descriptive statistics of the nominal GDP of Azerbaijan by years	
Mean	52422515
Standard Error	4142345.177
Median	50880900
Mode	#N/A
Standard Deviation	18525130.8
Sample Variance	3.4318E+14
Kurtosis	-0.4454802
Skewness	-0.35151696
Range	65568800
Minimum	13238700
Maximum	78807500
Sum	1048450300
Count	20
Largest (1)	78807500
Smallest (1)	13238700
Confidence Level (95.0%)	8670028.097

The statistical analysis provides a summary of the nominal GDP of Azerbaijan over a 20-year period. The mean nominal GDP is 52,422,515, with a median of 50,880,900, indicating a relatively symmetrical distribution of values around the centre, which is further supported by a skewness of -0.35, reflecting a slight leftward asymmetry. The standard deviation of 18,525,130.8 signifies considerable variability in GDP values across the years. The range of 65,568,800, from a minimum of 13,238,700 to a maximum of 78,807,500, highlights the substantial economic growth and fluctuation over the observed timeframe. The kurtosis value of -0.45 suggests a distribution that is slightly flatter than a normal distribution, indicating fewer extreme outliers than would be expected in a normal distribution. The 95% confidence interval for the mean, with a margin of error of approximately 8,670,028, suggests that the true mean nominal GDP for the population from which this sample is drawn is estimated to lie between approximately 43,752,487 and 61,092,543. The absence of a mode, as indicated by the #N/A value, confirms that no single GDP value repeats within the dataset.

Table 4.

Descriptive statistics of the nominal GDP of Turkey by years

Descriptive statistics of the nominal GDP of Türkiye by years	
Mean	828964287.6
Standard Error	40607664.75
Median	829325256.9
Mode	#N/A
Standard Deviation	181602997.6
Sample Variance	3.29796E+16
Kurtosis	2.117822692
Skewness	0.824394923
Range	816940090.3
Minimum	506314717.7
Maximum	1323254808
Sum	16579285753
Count	20
Largest(1)	1323254808
Smallest(1)	506314717.7
Confidence Level(95.0%)	84992819.11

The provided descriptive statistics summarise Türkiye's nominal GDP over a 20-year period, revealing

key characteristics of its central tendency, dispersion, and distributional shape. The mean nominal GDP is approximately 828.96 billion units, with a median of 829.33 billion units, indicating a symmetric central tendency with minimal distortion from outliers. The absence of a mode (#N/A) is consistent with continuous time-series data where exact repetitions are unlikely. The data exhibit substantial volatility, as reflected in a standard deviation of 181.60 billion units and a sample variance of 3.298×10^{16}, highlighting significant annual fluctuations in nominal output, which align with periods of economic instability, inflationary pressures, and external shocks experienced by Türkiye.

The range of 816.94 billion units, spanning from a minimum of 506.31 billion to a maximum of 1,323.25 billion, illustrates a more than 2.6-fold increase in nominal GDP across the period. This growth captures both real economic expansion and nominal effects, particularly inflation. The distribution is right-skewed (skewness = 0.824), indicating that some years had exceptionally high GDP values, pulling the tail to the right—a pattern typical in economies undergoing phases of rapid nominal growth. The kurtosis value of 2.118 suggests a distribution with lighter tails and a flatter peak compared to a normal distribution, implying a lower likelihood of extreme outliers than might otherwise be expected.

The standard error of the mean is 40.61 billion, denoting the precision of the sample mean estimate. The 95% confidence interval margin of error is 84.99 billion, yielding an interval of approximately 828.96 ± 84.99 billion units. This range accounts for sampling variability and underscores the uncertainty inherent in estimating the central tendency from a volatile economic series. The sum of nominal GDP over the 20 years totals 16.58 trillion units, providing a measure of cumulative economic output in nominal terms.

Economically, these statistics reflect Türkiye's trajectory through periods of growth and instability, with high variability underscoring sensitivity to monetary policy, exchange rate movements, and global economic conditions. However, these nominal figures do not adjust for inflation; thus, real GDP analysis would be necessary to assess true economic growth. Additionally, per capita GDP would offer further insight into changes in living standards. While descriptive statistics provide a useful snapshot, they do not capture temporal dynamics such as trends, cycles, or structural breaks, which would require time-series econometric methods for deeper analysis.

Table 5.

Covariance between Trade Turnover and Nominal GDP of Azerbaijan

	Trade turnover	*GDP of Azerbaijan*
Trade turnover	**3,722,955,542,066.39**	
GDP of Azerbaijan	**18,138,290,655,141.70**	**326,021,447,762,275.00**

The provided data presents key macroeconomic indicators for Azerbaijan, illustrating the scale of its international trade relative to its domestic economy. The total trade turnover, representing the sum of exports and imports, is recorded at 3,722,955,542,066.39 (presumably in Azerbaijani Manat, AZN). This figure is contextualised against the nation's Gross Domestic Product (GDP)—the total value of all goods and services produced domestically—which stands at 18,138,290,655,141.39 AZN. The relationship between these two metrics is analytically significant; comparing trade turnover to GDP yields a trade-to-GDP ratio of approximately 20.5%. This ratio serves as a standard measure of an economy's openness and integration into global markets. A ratio of this magnitude indicates a moderate level of trade dependency, suggesting that while international trade is a substantial component of Azerbaijan's economic activity, the domestic market constitutes the larger share of overall economic output. For a resource-rich nation like Azerbaijan, a significant portion of this trade flow is typically attributed to hydrocarbon exports, meaning the economy maintains vital global linkages while remaining substantially anchored in domestic production and consumption. A third, substantially larger figure (326,021,447,762,275.00) is included without a clear label; its relevance to Azerbaijan's standalone economic metrics is ambiguous, and it may represent a regional aggregate or unrelated data point. Therefore, for an accurate assessment of Azerbaijan's economic structure, the primary focus should remain on the explicitly labelled trade turnover and GDP figures.

Table 6

Covariance between Trade Turnover and Nominal GDP of Türkiye

	Trade turnover	*GDP of Türkiye*
Trade turnover	**3.72296E+12**	
GDP of Türkiye	**2.30766E+14**	**3.13307E+16**

The table presents two key macroeconomic indicators for Türkiye: its Trade Turnover and Gross Domestic Product (GDP). The trade turnover, representing the total value of exports and imports, is quantified at approximately 3.72 trillion units of currency (3.72296E+12). The nation's GDP, a measure of its total economic output, is reported at approximately 230.77 trillion units of currency (2.30766E+14). These figures illustrate the substantial scale of the Turkish

economy. For context, a significantly larger comparative figure of approximately 31.33 quadrillion units (3.13307E+16) is also provided, which serves as a benchmark, likely representing a global aggregate, regional total, or the GDP of a major economic bloc, against which Türkiye's economic magnitude can be assessed.

Table 7

Correlation between Trade Turnover and Nominal GDP of Azerbaijan

	Trade turnover	*GDP of Azerbaijan*
Trade turnover	**1**	
GDP of Azerbaijan	**0.520630188**	**1**

The table presents the correlation coefficient between Trade Turnover and the GDP of Azerbaijan. The value for Trade Turnover with itself is necessarily a perfect positive correlation of 1, which serves as a baseline. The critical statistic is the correlation between the two distinct variables, measured at approximately 0.521. This indicates a moderately strong positive linear relationship. Specifically, as the Trade Turnover of Azerbaijan increases, its GDP also tends to increase, and vice versa. The strength of this association, while not perfect, suggests that trade activity is a significant and positively correlated component of the nation's overall economic output. In empirical economic analysis, a correlation of this magnitude typically implies that fluctuations in trade are substantively linked to concurrent fluctuations in the size of the economy, underscoring the importance of the external sector for economic performance.

Table 8

Correlation between Trade Turnover and Nominal GDP of Türkiye

	Trade turnover	*GDP of Türkiye*
Trade turnover	**1**	
GDP of Türkiye	**0.675683415**	**1**

The presented correlation matrix quantifies the linear relationship between Trade Turnover and the Gross Domestic Product (GDP) of Türkiye. The correlation of Trade Turnover with itself is, by definition, a perfect positive correlation of 1. The substantive coefficient of interest is approximately 0.676, indicating a strong positive correlation between the two variables. This statistically significant relationship suggests that movements in Türkiye's total trade volume are closely associated with concurrent movements in its overall economic output. A coefficient of this magnitude implies that trade activity is not merely a component of GDP but is dynamically and strongly linked to its fluctuations. This finding underscores the integral role of the external sector—encompassing both exports and imports—within the broader Turkish economy, highlighting its sensitivity to international trade dynamics.

Table 9

Analysis of some significant changes in the Trade turnover

Changes in trade turnover between Azerbaijan and Türkiye over the years (by thousand dollars)		
2006	31.28%	184,224.1
2007	117.40%	907,710.5
2008	-14.73%	-247,569.4
2009	-29.21%	-418,721.9
2010	-7.12%	-72,268.1
2011	86.58%	815,867.9
2012	20.60%	362,226.2
2013	-6.16%	-130,639.5
2014	-10.08%	-200,656.5
2015	48.04%	859,507.9
2016	-10.62%	-281,400.9
2017	12.69%	300,337.5
2018	27.56%	735,231.0
2019	32.52%	1,106,759.2
2020	-7.75%	-349,302.5
2021	12.06%	501,526.3
2022	25.33%	1,180,702.3
2023	30.95%	1,808,104.5
2024	-19.87%	-1,520,417.6

Sharp increases after 2006-2007

The extraordinary surge in bilateral trade turnover in 2007 is fundamentally attributed to the **full-scale operational launch of the Baku-Tbilisi-Ceyhan (BTC) pipeline**.

The Baku-Tbilisi-Ceyhan pipeline's commencement of full commercial operations in mid-2006 had a profound and multifaceted impact on the trade turnover between Azerbaijan and Türkiye in 2007. While the pipeline itself is a transit corridor for Azerbaijani oil to world markets, its operation fundamentally altered the bilateral economic relationship. Most directly, it created a massive new stream of "transit trade" in the form of Azerbaijani crude oil physically moving through Turkish territory to the Ceyhan terminal for export. This transit is a service exported by Türkiye, generating significant and stable revenue in the form of transit fees paid to the Turkish state and BOTAŞ, the state pipeline company. These fees, while not fully reflected in standard goods trade statistics, represented a major financial inflow and a new, permanent pillar of bilateral economic cooperation.

Furthermore, the pipeline's success solidified a strategic energy partnership that transcended simple trade. It turned Türkiye into the crucial energy gateway for Azerbaijan's main export commodity, binding the two economies together in a long-term, high-stakes venture. This strategic alignment boosted confidence and likely stimulated other areas of trade and investment. The reliable flow of billions of dollars in oil revenues into Azerbaijan's state coffers also dramatically increased Azerbaijan's purchasing power and economic activity. In 2007, this newfound wealth began to translate into increased imports from Türkiye, including construction materials, machinery, consumer goods, and services, as Azerbaijan embarked on infrastructure and development projects. Consequently, while the total trade turnover figures for 2007 showed strong growth, their composition shifted. Azerbaijan's exports to Türkiye, now dominated by crude oil delivered via BTC, saw a substantial increase in value. Simultaneously, Türkiye's exports to Azerbaijan also rose, fueled by the latter's oil-boom economy. Thus, in 2007, the BTC pipeline acted as both a direct channel for a major commodity and a catalyst for broader economic integration, transforming the trade relationship from a modest bilateral exchange into a deep, strategic interdependence centred on energy geopolitics and its resulting economic spillovers.

The Fall in 2009

The principal catalyst for the abrupt contraction in bilateral trade turnover between Azerbaijan and Türkiye in 2009 was the exogenous shock of the Global Financial Crisis and its concomitant worldwide recession. This event precipitated a severe, synchronised

downturn in global economic activity, which transmitted to the bilateral trade dynamic through two interconnected channels. First, it induced a profound contraction in aggregate demand within both economies, sharply reducing import appetites across sectors. More critically, it triggered a historic collapse in international commodity markets, most significantly in the price of crude oil. As a hydrocarbon-dependent economy, Azerbaijan experienced an immediate and drastic reduction in export revenues and fiscal resources. This commodity price shock effectively constrained the nation's import capacity, particularly for the capital goods, construction materials, and manufactured consumer products that constituted the core of Turkish exports to Azerbaijan. Consequently, the bilateral trade relationship, embedded within globalised financial and commodity networks, was subjected to a powerful negative demand and terms-of-trade shock, directly manifesting in the sharp decline in recorded trade turnover for that period.

Growth after 2018

Additionally, the **Trans-Anatolian Natural Gas Pipeline (TANAP**), operational since 2018, represents a critical infrastructure project that has fundamentally recalibrated the economic relationship between Azerbaijan and Türkiye. Its primary and most quantifiable impact on bilateral trade turnover has been transformative, yet markedly asymmetric. The pipeline, forming the central segment of the Southern Gas Corridor, directly facilitates the export of Azerbaijani natural gas from the Shah Deniz II field to Türkiye and onward to European markets. This has precipitated a dramatic surge in the value of Azerbaijan's exports to its western neighbour. Consequently, Türkiye has ascended to become Azerbaijan's principal trading partner, a position overwhelmingly underpinned by hydrocarbon exports. Aggregate trade turnover figures have thus reached unprecedented levels, largely driven by this single commodity flow and creating a significant trade surplus for Azerbaijan.

Beyond the immediate effect on merchandise trade statistics, TANAP's influence extends into the strategic and structural realms of the bilateral relationship. For Türkiye, the project enhances energy security by diversifying import sources and provides substantial transit fee revenue, embedding mutual economic interdependence. This mega-project, executed as a joint venture between SOCAR and BOTAŞ, has also functioned as a formidable signal of long-term political and economic alignment, fostering increased investor confidence across sectors. The collaborative success has established a template for further ambitious energy and infrastructure initiatives, including discussions on renewable energy cooperation and enhanced electrical interconnectivity. In this sense, TANAP has acted as a catalyst for deeper economic integration that transcends the energy sector alone.

However, the project's effect on the composition and balance of trade reveals a more complex narrative. The trade relationship remains characterised by a pronounced lopsidedness. Azerbaijan's export portfolio to Türkiye is dominated by natural gas, with limited evidence of a strong spillover effect stimulating non-energy exports. Conversely, Türkiye exports a diversified array of goods—including machinery, manufactured products, and foodstuffs—to Azerbaijan, but the total value of these exports is eclipsed by the volume of gas imports. This structural asymmetry highlights a key limitation: while TANAP has massively increased total trade turnover, it has not, in itself, addressed broader challenges of economic diversification within the bilateral trade framework. There exists a risk that the substantial foreign currency inflows from gas could reinforce a resource-dependent export structure for Azerbaijan, potentially crowding out other tradable sectors through exchange rate mechanisms.

Ultimately, the TANAP project has irrevocably altered the scale and strategic depth of Azerbaijan-Türkiye trade relations. It has moved the partnership from a primarily political and cultural affinity to one anchored in a concrete, high-stakes economic interdependence. The pipeline is the cornerstone of a shared energy geopolitics that generates continuous revenue and strategic leverage for both states. The future trajectory of bilateral trade turnover will likely depend on the capacity of both nations to leverage the capital, infrastructure, and political capital generated by TANAP to foster more diversified commercial exchanges. Success in this endeavour would involve channelling the project's success into investments, trade facilitation, and logistics projects, such as the envisioned Zangezur transport corridor, that can stimulate balanced, multi-sectoral trade growth, thereby ensuring the economic partnership matures beyond its current, energy-centric foundation.

Signift decrease in the Trade turnover in 2024

The sharp decline in bilateral trade turnover between Azerbaijan and Türkiye in 2024 is predominantly attributable to a significant correction in the value of energy exports, specifically natural gas, following the extraordinary price bubble of the preceding two years. This dynamic represents a statistical normalisation rather than a contraction in economic cooperation. The outbreak of the Russia-Ukraine war in 2022 triggered a global energy crisis, drastically reducing Russian pipeline flows to Europe and elevating Azerbaijan, as a secure alternative supplier, to a position of strategic importance. Consequently, benchmark natural gas prices, to which long-term supply contracts are often linked, reached historic peaks throughout 2022 and much of 2023. This price surge inflated the dollar-denominated value of Azerbaijan's energy exports to Türkiye, which serves as both a key consumer and a critical transit corridor, thereby creating an artificially high baseline for total trade turnover.

By 2024, the market had undergone a pronounced correction. Successful European diversification efforts via liquefied natural gas (LNG), adequate storage levels, and tempered demand led to a stabilisation and sharp decline in global gas prices. While the physical volume of Azerbaijani gas deliveries to and through Türkiye likely remained stable or even increased, the unit price per cubic meter fell by approximately 70-80 percent from its peak. Given that hydrocarbons consistently constitute the overwhelming majority—typically between 60 and 80 percent—of Azerbaijan's export

value to Türkiye, this price normalisation exerted a disproportionate downward pull on the aggregate trade figure. The decline is thus fundamentally a reflection of the transition from a period of geopolitical premium and record-high energy prices back toward more traditional market conditions, drastically reducing the dollar valuation of an otherwise steady or growing physical trade flow.

Conclusion

This statistical analysis has traced the dynamic evolution of trade turnover between Azerbaijan and Türkiye from 2005 to 2024, revealing a relationship characterized by robust long-term growth, significant volatility, and deepening strategic interdependence. The study employed descriptive statistics, time-series analysis, and measures of dependence to move beyond mere trend description, uncovering the structural and contextual drivers behind the data.

In summary, the Azerbaijan-Türkiye trade partnership has matured from a culturally and politically aligned relationship into one anchored in concrete, high-stakes economic interdependence, primarily through energy and logistics megaprojects. While these projects have successfully scaled the economic relationship and provided strategic depth, they have also reinforced a commodity-dependent trade structure.

References

1. Türkiye Azerbaijan Economic Relations: Bilateral Revealed Comparative Advantage Perspective A. Beyhan AKAY 2023
2. Hüseynova, S. Kapsayici Kalkinma Göstergelerinin Ekonomik Kalkinma Üzerindeki Etkisi. *Scientific Collection «InterConf+»*, (30), 28-31.
3. Elvin Alirzayev & Sara Huseynova, 2025. "Empirical Evidence Of J-Curve Effect And Marshall Lerner Condition: Case Of Azerbaijan," The Scientific-Analytical Journal "Economic Reforms", Center for Analysis of Economic Reforms and Communication of the Republic of Azerbaijan, vol. 2025(1), pages 40-56, June.
4. Charkasov, M., & Huseynova, S. (2024). Azerbaycan'da Doğrudan Yabancı Yatırım Girişlerine Etki Eden Faktörlerin ARDL Sınır Testi Yaklaşımı ile Araştırılması.
5. HUSEYNOVA, S. The analysis shows that theoretically, economically, food security covers a system of relationships that includes the production, transportation, pro. *İqtisadi və Siyasi Elmlər Jurnalı*, *120*.
6. State Statistical Committee of the Republic of Azerbaijan. (2005–2024). *Foreign trade statistics of Azerbaijan*. Baku: SSCAR. Retrieved from: https://www.stat.gov.az
7. Turkish Statistical Institute (TURKSTAT). (2005–2024). *Foreign trade statistics*. Ankara: TURKSTAT. Retrieved from: https://www.tuik.gov.tr
8. World Bank. (2024). *World Development Indicators*. Washington, DC: World Bank. Retrieved from: https://data.worldbank.org
9. World Trade Organization (WTO). (2023). *International trade statistics*. Geneva: WTO. Retrieved from: https://www.wto.org
10. International Monetary Fund (IMF). (2024). *Direction of Trade Statistics (DOTS)*. Washington, DC: IMF. Retrieved from: https://data.imf.org
11. United Nations Conference on Trade and Development (UNCTAD). (2023). *UNCTADstat database*. Geneva: United Nations. Retrieved from: https://unctadstat.unctad.org
12. Huseynov, S., & Babazade, G. S. (2021). Trade integration and economic cooperation between Azerbaijan and Türkiye. *Journal of Economic Studies*, 48(3), 512–528.
13. Balassa, B. (1965). Trade liberalization and revealed comparative advantage. *The Manchester School*, 33(2), 99–123.
14. Krugman, P. R., Obstfeld, M., & Melitz, M. J. (2018). *International economics: Theory and policy* (11th ed.). Pearson Education.
15. Helpman, E., & Krugman, P. (1985). *Market structure and foreign trade*. Cambridge, MA: MIT Press.
16. Huseynova, S., & Charkasov, M. (2024). Long-run Relationship Between Türkiye and SHANGHAI Cooperation Organization Stock Markets: Cointegration Analysis. *Journal of Statistics and Applied Sciences*, (10), 1-9.
17. Huseynova, S. M., & Hajizada, T. J. (2024). Analysis of the Stability of the Banking Sector of Azerbaijan in Conditions of Economic Crisıs Based on the Econometric Model. *Статистика и экономика*, *21*(2), 35-49.
18. Гусейнова, С. М. (2014). Проблемы вступления Азербайджана в ВТО. *Экономика и предпринимательство*, (4-2), 758-761.
19. Anderson, J. E., & van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. *American Economic Review*, 93(1), 170–192.
20. Feenstra, R. C. (2004). *Advanced international trade: Theory and evidence*. Princeton, NJ: Princeton University Press.
21. Helpman, E., Melitz, M., & Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. *Quarterly Journal of Economics*, 123(2), 441–487.
22. Wooldridge, J. M. (2016). *Introductory econometrics: A modern approach* (6th ed.). Boston: Cengage Learning.
23. Gujarati, D. N., & Porter, D. C. (2009). *Basic econometrics* (5th ed.). New York: McGraw-Hill.

HISTORICAL SCIENCES

THE FIRST AND SECOND STAGES OF THE DUTCH REVOLUTION

Mehdiyeva A.
Doctor of Philosophy in History, Associate Professor,
Azerbaijan State Pedagogical University
Baku, Republic of Azerbaijan
ORCID ID: https://orcid.org/0000-0001-7819-3103
DOI: 10.5281/zenodo.18084038

ABSTRACT

The revolutions in the history of mankind are associated with the fact that over many years of accumulation, unsolvable and the problems of society have reached their limit. Revolutions take on a particularly serious character in the presence of conflicts and contradictions between productive forces and production relations. From this point of view, the Dutch Revolution attracts attention. The ripening of all conditions for their independence prompted the Dutch to formalize this process since the end of the XV century. However, the unfavorable political situation conditioned their existence within the Holy Roman Empire on preferential terms. But with the coming to power of Philip II, the situation completely changed. In a short period of time, serious discounted and problems in all areas (political, economic, social and religious) caused speeches in the Netherlands, which ruled by the Spaniards by harsh methods. Although the people expressed their demands with an iconoclasm uprising, the dictatorship created by Duke Alba suppressed the uprising, and the harsh and merciless policy of terrorism brought the situation in the country to the limit. As a result, the processes taking place in the first and second stages of the Dutch revolution led to the separation of the country into two parts and the creation of the first bourgeois Republic as the Republic of the United Provinces for the first time in history.

Keywords: Dutch Revolution, stage, Holy Roman Empire, rich region, England – Spain contradictions, catholic church.

İNTRODUCTİON

The Dutch Revolution (sometimes known as the Dutch Revolution) was a religious – ideological, political, and socio – economic struggle for independence by seventeen provinces from Spanish rule. Known in Dutch as the Nederlandse Opstand and in Spanish as the Revuelta de los paises Bajos, it was also known as the Eighty Years` War or the War of Independence. An important result of the revolution was the creation of the United Provinces Republic. Modern Belgium and Luxembourg, which remained under the rule of the Habsburg dynasty, were called the Southern Netherlands. The Dutch Revolution was the first successful national – liberation movement in Europe and led to the creation of the first modern European Federation of Republics [15]. The struggle for freedom in the Netherlands was associated with the name of the representatives of the House of Nassau, the House of Oran. They were led by the Prince of Oran, William of Nassau (1533 – 1584). This person is known in historical literature as William I of Oran [7]. The first phase of the revolution was associated with the iconoclastic movement or rebellion (nid. Beeldenstorm), which was observed in 1566 with mass anti – Catholic riots in several regions of Flanders. Later, events intensified in Antwerp. Special detachments were organized in Luxembourg and Artois to prevent looting. During the Iconoclast Revolt, 5.500 churches and monasteries were severely damaged [7]. The announcement by Margaret of Parma, the stadtholder of the Netherlands, that the Inquistion had been suspended and Calvinism had been legalized, weakened the rebellion in the country, while the organization of the punitive expedition by the Duke of Alba led to the resurgence of the rebellion.

The situation in the Netherlands on the eve of the revolution

After the abdication of Charles V of Habsburg, the Netherlands passed to his successor Philip II as one of the Habsburg possessions. These lands were annexed to the Habsburg Empire through diplomatic marriage in the 1570s. [9, 531]. The Netherlands was a densely populated and wealthy region. Philip II therefore treated this region as a major source of income for pursuing an active foreign policy. However, in the middle of the 16th century, the economic situation in the Netherlands became extremely acute. This was due to the crisis observed in Ghent, Bruges and Ypres, the centers of the ancient craft of mining and textile production, and the accompanying rapid impoverishment of the population, the “price revolution”, and the crop failure and famine of 1556 – 1557. The collapse of feudal relations, the accumulation of primary capital, and the formation of capitalism were not at the same level in the southern and northern provinces of the Netherlands. Although manufacturing production, capitalist farmers, and free farming were quite developed in the northern provinces (Holland and Zeeland), the manufactures located in the north of the country lagged behind Flanders and Brabant in terms of production volume.

Contemporaries believed that the economic decline and the decline in living standards were due to the Spanish introduction of new management methods and the lack of attention to the vital needs of the Netherlands. The financial exploitation of the Netherlands by Spain was reflected in the subsidies granted to the Spaniards, indirect taxes, etc., formalized by the Estates General. Economic pressure (the collection of large amounts of duties and taxes, the closure of the access of Dutch merchants to the Spanish colonies, the ban on

Dutch trade relations with England due to Anglo – Spanish conflicts, etc.) led to the strengthening of anti – Spanish sentiment in all strata of Dutch society [15].

The main support of the Spanish absolutism in the Netherlands was the Catholic Church. For this reason, the Protestant sentiment of the local population first manifested itself in the form of Lutheranism, Anabaptism, and then Calvinism. According to the Spaniards, the main reason for the emergence of dissent was the decline in tax revenue. In order to eradicate Calvinism, King Philip II of Spain intensified religious persecution, strengthened the power of the Catholic Church in the Netherlands, and gave the Inquisition court broader powers than during the reign of Charles V. Philip II was distinguished by his uncompromising stance against the particularism of the provinces in the country. He did not accept the traditional customs of isolation of the Dutch, local freedoms and privileges, and limited the rights of local governing bodies (Supreme and local states, Council of State). In order to win over the Dutch nobility to his side, he attracted to the Council of State such prominent nobles as William I of Orange, Count Laroraal Egment, Admiral Philip de Montmorency Horn, Baron Hendrik van Brederode, etc. At the same time, he appointed William I of Oran as Stadtholder of Holland, Zeeland and Utrecht (1559), and Count Laroraal Egmont as Stadtholder of Flanders. However, gradually all power passed into the hands of the Spaniards, who were concentrated in the Council of State, and the administration was given to Margaret of Parma, and Cardinal Antonio Perreno de Granvella, who was also the head of the Privy Council, took part in the administration of the province [15].

The protest mood first arose among the Spanish and representatives of the local nobility, dissatisfied with the rule of the Catholic Church. They tried to improve their economic situation by confiscating church property as part of the church reform. The noble group, centered around William I of Oran and Count Laroraal Egmont, believed that the interests of the Netherlands were being sacrificed to Spain, and that the policies pursued by Philip II were preparing the ground for popular uprisings. They succeeded in removing the Spaniards from the Council of State and granting broad powers to the local nobles, who were able to successfully resole the growing social contradictions. In 1563, the aristocratic opposition in the Council of State demanded the resignation of A.P.Granvela. Following this, representatives of the petty nobility presented a petition to Margaret of Parma asking for the restoration of the provinces` former freedoms and privileges, the withdrawal of the Spanish armies, and the abolition or softening of the banners against heretics. Under their pressure, in 1564 the Spanish king dismissed Granvela [15].

Seeing no significant changes in the activities of the Spanish authorities, the opposition Dutch nobles formed the "Compromise" alliance in 1565. During 1566, its members presented two more petitions to Margaret of Parma, outlining their demands (stopping the violation of liberties, convening the Estates General, and softening the laws against heretics). They threatened to launch a "general uprising and rebellion" if their demands were not met. However, no response came from the official authorities. At that time, the vast mass of the poor population was increasingly attracted to religious movements, and the Calvinist consistories carried out a great propaganda work against the Catholic Church and the Spanish regime.

In fact, the processes taking place in the Netherlands were connected with serious mistakes made by the Spanish king Philip II. Unlike his father, Philip II did not understand the problems of the Dutch and did not want to understand them. The Netherlands was ruled by the Privy Council. Harsh persecutions and heavy taxes made the situation in the country extremely difficult. Hunger and strict control made the people dissatisfied with the Catholics. Although the issue of softening the oppression in the administration was repeatedly raised, the discontented were said with the insulting phrase "Ce ne sont pas que les queux" (They are just beggars). At the same time, the eyes and their motto "We will not obey tyrants and bandits" became a symbol of the struggle against Spain [12].

Philip II issued a series of edicts against heretics, including the Bloody Edict of September 25, 1550, under which thousands of people were killed. Under these laws, reminiscent of the Draconian laws, Spain sought to break and subjugate the freedom – lowing people of the Netherlands. Historians of the time gave horrific accounts of the activities of monks who "sent the reformers to the stake instead of rejecting their ideas". In the Netherlands, one thing was clear: Philip II planned to completely colonize the country. Spanish feudal lords and clergy were trying to seize the main centers of income in the Netherlands. The Spanish king treated the Dutch population as a "gathering of heretics and drunkards" and spoke of them with hatred. Under the policies of the Spanish King Philip II, Dutch merchants were restricted from trading with India and America, and their activities in European trade were given little space. Spain`s harsh and ruthless policies led to the outbreak of a rebellion against the center in the Netherlands.

The Habsburgs received more revenue from the Dutch cities than from the gold and silver imported from the New World. The Dutch cities were considered the richest in Europe. Politically, the Supreme States were the central reprecentative bodies representing the national forces against the tax – collecting bodies of the foreign dynasty, and in the provinces, each province had its own Provincial Council. In addition, each city had its own governing body, each of the 17 provinces and each city had special privileges. This limited royal power in the Netherlands. The situation changed in the second half of the 16th century. The fanatically Catholic king Philip II of Habsburg abolished the historically formed rights of the local population and imposed taxed that the country could not afford.

In the second half of the 16th century, the people`s struggle for freedom against Spanish rule in the Netherlands was closely linked to their struggle for religious freedom. Although two Lutherans were burned at the stake in the Netherlands in 1523, Lutheranism, which preached loyalty to the Spanish king Philip II, who was alien to the Dutch, failed to gain success and spread widely in the country. In 1560, the majority of

Protestants in the Netherlands were Calvinists. Although the Spanish Inquisition ruled the country, Calvinism became the ideological basis of the Dutch Revolution [13].

Iconoclasm and its historical roots

Iconoclasm, the attack on and destruction of icons and other images, has a long history. A significant event in iconoclasm occurred in ancient Egypt during the Amarna period. Pharaoh Akhenaten opposed the Amun priests, who were fighting for power and influence, and ordered the destruction of Amun temples and statues [10, 802]. According to the Tanakh, all idols and statues of Canaan were destroyed. In Byzantium, in the 8th and early 9th centuries, there was a large – scale religious and political movement against the veneration of icons (Greek. Eikon) [1, 92 – 94]. The movement consisted of two phases and had serious consequences [6].

The iconoclastic movement was widespread in Europe during the late Middle Ages. Political and economic events during this period led to the revial of the iconoclastic movement and its adaptation to the new era. Strong iconoclastic revolts occurred in Basel (1529), Zurich (1523), Copenhagen (1530), Münster (1534), Geneva (1535), Augsburg (1537), Scotland (1559), Rouen (1560), Sainte – Anne and La Rochelle (1562) and other parts of Europe [7].

In Europe, attitudes towards icons varied during the Reformation. According to ancient Jewish religious belief (Azeret ha – Dibrot), Moses was given the Ten Commandments in a collection of religious and moral teachings given to him by God on two tablets of stone on Mount Sinai. This collection is found in the Book of Exodus of the Torah. The second paragraph of this collection states that you shall not make for yourself a carved image, nor shall you make for yourself any likeness of anything above, below, or in the water, nor shall you bow down to them or worship them [14].

Moses, enraged by the Israelites, breaks the stone tablets containing the Ten Commandments that Jehovah gave him (Rembrandt, 1659)

While the famous scholar and reformer John Calvin, based on his interpretation of this clause, demanded the complete removal of icons from the church, Martin Luther paid more attention to the difference between religious images and their acceptance. Radical groups of iconoclasts operated in the southern regions of Germany and Switzerland. Large – scale iconoclast riots occurred in Geneva. Wilrich Zwingli was active in the fight against iconoclasm. It was with the Iconoclast revolt of 1566 that the bourgeois revolution in the Netherlands began. During this revolt, numerous icons and statues of saints were destroyed in Catholic churches and monasteries in the country. It should be noted that the rebels were not content with destroying only images and statues of saints in churches; they also took the same approach to other objects of worship, such as candelabrums (a decorative container or stand with branches for several candles or various lamps) and monstrances (ostensoriums – gold and silver vessels displayed in churches and containing consecrated bread) [3, 11 – 12]. In modern times, calling for someone to be hit with a candelabra is like accusing that person of fraud [18, 275].

In religious terms, iconoclasm is considered a phenomenon inherent in Christianity, extending back to the Byzantine and Protestant Reformations. In this sense, icons could be understood as any object associated with religious institutions. According to Irish historian Eamonn Duffy, iconoclasm was seen as a key rite of the Reformation, a quasi – ritual act to abolish past beliefs and religious practices, and "the mysteries of forgetting". Dutch historian Peter Gale, who studied the activities of the iconoclasts in the Netherlands, described their actions as "an injury to the millennial past" [16, 1].

Iconoclasm can also be understood as the criticism or rejection of established and widely held beliefs that are considered erroneous or a relic of the past.

The differences in historical events and methods that exit have made iconoclasm the subject of numerous studies.

The first phase of the Dutch bourgeois revolution

In November 1565, about 500 opposition nobles united in an alliance called the Agreement or Compromise and drafted a petition to the government. They presented their demands to the Spanish viceroy, Margaret of Parma, in Brussels on 5 April 1566. This document demanded the restoration of the country`s liberties, the cessation of religious persecution, and the convocation of the Estates General. It was stated that failure to meet their demands would result in general

unrest and uprisings, the first victims of which would be the nobility. The poor clothing of the nobles who presented the petition caused ridicule from the courtiers. One of the courtiers called them beggars (french for "eye"). This nickname was adopted by the opposition, and later all the Dutch rebels and freedom fighters began to be called by this name. Frightened by the warning, Margaret promised to convey the nobles` request to the king and decided to limit the persecution of heretics until he answered [11].

The representatives of the nobility were dissatisfied with the outcome of the negotiations. They used the nickname "eye" and demonstratively sewed the image of a beggar`s bag on their clothes. In this way, the nobles wanted to show the failure of the April 5 appeal and at the same time the Spanish plundering their country. Taking the example of the nobles, the Calvinist bourgeoisie created their own alliance under the name of the "Menchants` Compromise". As the goverment was slow to respond, the nobles began negatiations with the German Protestant principalities and the French Huguenot nobility for assistance in the event of armed conflict. Domestically, the nobles concluded an agreement with the consistories in the summer of 1566 to act together and received money from them to raise soldiers from Germany.

The iconoclastic movement played a major role in the history of the Dutch people. The first act of the war of independence in the Hetherlands was associated with the iconoclastic movement. On August 11, 1566, armed mobs raised by the consistories in the cities of Hondshot, Armantier and Kassel began to attack churches, break statues of saints and icons. Valuable items seized from churches were taken to be used for charitable purposes. The government and local authorities were rendered inoperative and unable to take practical action.

Depiction of saints destroyed by iconoclasts in the church of Utrecht (Netherlands) (1566)

On August 22, 1566, the uprising spread to Antwerp. The initiators of the iconoclastic demonstrations were artisans and the city`s poop. The next day, iconoclastic demonstrations also began in Toume. Up to 800 armed peasants from the surrounding villages joined the city population in destroying churches. The rebels burned the financial and land documents of monasteries and churches. Armed groups were created at the expense of confiscated church property.

In Middelburg (Zealand) the iconoclastic uprisings began on August 22, 1566. The people, supported by some members of the city magistrate, not only destroyed the churches, but also freed the Calvinists in the city prison. In Amsterdam and Vlissingen, some magistrates from the ranks of the wealthy bourgeoisie directly and indirectly assisted the iconiclastic movements during the uprising. In Utrecht the people not only destroyed the churches, but also began to interfere in the affairs of the courts and city administration.

In a short time, the iconoclastic movement had spread to almost all the provinces of the Netherlands. The number of churches and monasteries destroyed reached 5.500. Gradually, the movement spread from the south of the country to the north, and its base was Flanders, Brabant, Tume, Holland, Zeeland, and Utrecht. In the remote agrarian provinces of Luxembourg, Gennegau, Artois, and Helder, the movement developed poorly and covered only a few large cities.

The authorities, being powerless, were forced to make concessions. On August 23, 1566, Margaret of Parma was forced to announce the abolition of the Inquisition and the softening of the banners. The preaching of Calvinism was allowed. An amnesty was declared for the members of the noble alliance. The noble alliance, frightened by the power of the movement, accepted Margaret`s terms, released itself, and many of the its members, including Count Egmont and William of Orange, began to persecute the iconoclasts. The consistories, negotiating with the goverment, achieved new concessions and withdrew from the movement. The indecisive tactics of the consistories deprived the movement of leadership. Taking advantage of this, the goverment gathered its military forces and launched an offensive. In the spring of 1567, the iconoclastic movenent was suppressed.

Having received detailed information about the events taking place in the Netherlands, Philip II decided to punish the rebels mercilessly. In the summer of 1567, a well – trained Spanish army of 18.000 was sent to the Netherlands under the command of the Duke of Alba. Up to 100.000 people fled the country in fear. Among those who fled were William pf Orange and his brother Louis of Nassau. On August 23, 1567, Albanian troops entered Brussels.

Hard, ruthless and arrogant, Alba considered the executioner`s axe and the Inquisition bonfire to be the

most reliable means of governing the country. The "council for the investigation of sedition cases" established by Alba, who created a bloody regime of terror, knew only one punishment for those accused. The people called this court the "bloody council". During Alba`s reing, the number of people executed by the verdict of this court exceeded eight thousand. Alba`s goal was not only to intimidate the population, but also to fill the Spanish royal treasury. Among those executed were many wealthy merchants and prominent nobles.

William of Oran and his brother Louis of Nassau led a large mercenary army into the Netherlands, one from the south and the other from the north, to overthrow the regime of Alba. However, Alba, an experienced commander, defeated the soldiers of Louis of Nassau and forced the prince`s troops to retreat. William`s mercenary troops dispersed, unable to receive the promised reward. In order to weaken William of Orange`s position, the council investigation the rebellion accused him of attempting to seize power under the guise of relifious motives and confiscated his property. This prince`s 13 – year – old son was arrested and sent to Spain. Between 1568 and 1572, William of Orange invaded the Netherlands several times at the head of a mercenary army, but he was unsuccessful.

In order to reduce the importance of the general staff and ensure a continuous flow of money from the country, the Duke of Alba decided to carry out a radical "reform" in financial matters and immediately introduced 3 new taxes: 1) a 1 % tax on all types of property, 2) a 5 % tax on the purchase and sale of real estate, 3) a 10 tax on the sale of all goods. These 3 taxes were collectively called al – qabala.

The introduction of the levy meant a complete economic disaster for the Dutch economy. Even Alba`s close associates understood the danger of this decision. Even Philip II himself offered to soften the ducal regime and grant a general amnesty. Alba, who did not give up his stubbornness, agreed to postpone the introduction of the levy until 1571, deducting 2 million guilders from the annual tax [17, 25 – 26].

The second phase of the Dutch revolution

At this stage, a popular guerrilla war against the Spanish autocracy began. In that process, the forest and the sea eyes played an important role.

The harsh and ruthless policy of terror of the Duke of Alba could not break the determination of the Dutch people to fight. The forests of Flanders and Gennegau became a refuge for armed peasants, artisans and hired workers. They attacked and destroyed small groups of Spanish soldiers, priests, monks, and court officials who collaborated with the Spanish. These groups, known as forest eyes, relied on the help of the local population, who provided them with food and informed them of the movements of troops and authorities.

In the north, guerrilla warfare took a slightly different form. Here, sailors, fishermen, some shipowners, and Calvinist nobles would go out to sea in ships and attack Spanish shipping. These groups, called sea – eyes, used english ports as bases to help them weaken Spain. The sea – eyes not only captured and sank Spanish ships, but also often attacked coastal towns. William of Orange, who had fled to Germany, saw that their activities were successful, and as Stadtholder of the Netherlands, from 1568 he began to issue letters of marque to the navies, giving them the right to wage war against Alba, and to send them his officers.

The policy of William of Orange

In Germany, nobles who had fled the Netherlands had grouped around William of Orange. This group intended to receive help from foreign powers – German Lutheran princes, France and England – to fight against Spain. This help was to be obtained at the expense of the division of the Netherlands. Such projects included the transfer of Flanders and Artois to France, and Holland and Zealand to England. Brabant and some provinces were to be included in the German Empire under the right of electorate, primarily William of Orange.

In 1572, the tax on the head was introduced. As the Duke`s advisers said, it led to an economic disaster. Trade froze, shops closed, and manufactures stopped. The country was on the verge of a new uprising. The growing unrest in the country often took the form of open resistance. The states of the province of Utrecht, despite the brutal pressure of the Duke of Alba, categorically rejected the head. In order to punish Utrecht, the Duke of Alba withdrew military garrisons from there, neglecting the protection of the coastal cities.

The 1572 uprising in the northern provinces

At the end of March 1572, Queen Elizabeth, fearing a conflict with Spain, demanded that the English seamen leave English ports immediately.The seamen, deprived of a berth, put to sea in 24 ships and on April 1, 1572, under the command of Count de la Marque, captured the port of Brill in Zeeland. This event became the call to action for the beginning of the popular struggle for freedom in the northern provinces. On April 5, the townspeople of Vlissingen revolted and released detachments of seamen into the city. The important cities of the provinces of Holland and Zeeland declared their loyalty to the rebellion. Only Amsterda and Middelburg took a different position and remained loyal to the Catholics until 1578.

On September 21, 1572, Louis of Nassau surrendered to the troops of Duke Alba in an "honorable" peace. William of Orange, who had invaded the southern Netherlands from German territory, retreated to Germany on September 23 without achieving anything and abandoned his army.

Although William`s campaign was unsuccessfull, it attracted the main forces of the Spaniards, which allowed the rebellion in the north of the country to succeed. The rebel provinces successfully used the resulting lull. The military power of the rebels increased significantly and strengthened. In a short time, Medenblink, Hoom, Zirikzee, Udewater, Gouda, Leiden, Haarlem, Dordrecht and other cities were liberated from the Spaniards.

In Juli 1572, the States of Holland and Zeeland, meeting in Dortrecht, recognized William of Orange as their Stadholder. The prince was given supreme command over all naval and land forces, as well as supreme executive power. With the consent of the cities, the prince could appoint and dismiss all high officials. Freedom of religion was proclaimed in the States. William of Orange arrived in Holland in October 1572 to lead the movement [5, 227-228].

William of Orange was thus placed at the head of the rebellion, and was recognized as Governor – General and Stadtholder of Holland, Zeeland, Friesland, and Utrecht. Power was effectively divided between him and the States. Events entered a decisive phase as the rebels gained influence in the northern provinces.

At the end of 1572, the Duke of Alba launched a decisive offensive against the seceded provinces. The cities of Zutphen (Gelderland) and Naarden (North Holland) were taken by storm. The troops of the provinces that had joined the revolution were forced to leave Friesland. The inhabitants of Haarlem heroically resisted the Spanish for seven months, and only hunger forced them to surrender. The siege of Alkmaar, however, did not produce the desired results, and the Spanish had to lift the siege of the sity on October 8. On October 12, the rebel fleet defeated the Spanish fleet at Zuyderzee. These defeats completely undermined Alba`s authority. He was recalled to Spain. Alba left the Netherlands in December 1573, handing over his powers to the newly appointed judge in Madrid, Don Luis Requesens.

Rekezens, who replaced Alba, continued the offensive policy and tried to create a split in the opposition through some concessions. During Rekezens` time, the Spaniards managed to deal a serious blow to the opposition. The Spanish besieged Leiden in May 1574. Only the destruction of the sea walls by the Dutch saved the city from surrender after a long siege. The Spanish, terrified by the flood, lifted the siege. On October 4, 1574, the Dutch ships entered Leiden.

In 1575, the Spanish captured the important Zeeland port of Zierikzee. This was the last victory in the Spanish military campaign of 1572 – 1575. After the death of Rekezens in March 1576, power passed into the hands of the Council of State, whose members were unable to control the situation. In addition, in the summer of 1576, Spanish soldiers, who had not been paid for a long time, revolted and seized castles in a number of cities (Aalst, Antwerp, Ghent), began to rob and terrorize the population. The cities of Brabant began to organize resistance against the mercenaries. Although the members of the Council of State tried to prevent this, local volunteer groups in Brussels, led by officers loyal to William of Orange, arrested them on September 4, 1576. With the abolition of the Council of State, the last bastion of Spanish rule in the Netherlands fell.

Pacification of Ghent. National liberation movement in the southern provinces

In October 1576, the Estates General, who had seized power, met in Ghent. While the deputies in the Estates General were arguing, Spanish mercenaries attacked the city from the Antwerp fortress on November 4, 1576, destroying and plunderinf it. Up to 8.000 residents were killed, up to a thousand houses were hurned. The events that took place caused unrest in the country, and anti-Spanish demonstrations swept the entire south.

The events taking place in the country prompted the Estates – General to prepare an agreement. This document, called the Pacification of Ghent, was published on November 8. The Pacification of Ghent was formally a peace treaty between the northern provinces, which had risen against Spanish rule in 1572, and the southern provinces, which had begun a war of independence against Spanish rule in 1576, but remained loyal to Catholicism. The treaty provided for the withdrawal of Spanish troops from the country, the abolition of the "posters" against heretics and the laws imposed by Alba, religious tolerance, compensation for those whose property was confiscated by the Spanish, etc. At the same time, the document also expressed loyalty to Philip II. The war was limited to the rebellious Spanish troops. The proposal to confiscate church lands was rejected. The Netherlands and Zeeland were forbidden to spread of defend Calvinism outside their borders [2, 1 – 17].

The Eternal Edict

On November 3, 1576, the new viceroy of Philip II, Don Juan of Austria, arrived in Luxembourg. According to the Eternal Edict, signed between the States – General and Don Juan on February 12, 1577, Don Juan undertook to observe the Treaty of Ghent and the States – General to recognize him as viceroy of Philip II. On May 12, 1577, Don Juan entered Brussels in triumph. The northern provinces refused to recognize the "Eternal Edict". Don Juan was also not prepared to comply with the Eternal Edict. In June, he cunningly captured the impregnable fortress of Namur and began military operations against the troops of the States – General.

The whole country was again engulfed in popular uprisings. First, the city plebs and artisans of Brussels took up arms, overthrew the reactionary magistrate and elected a new one. Along with the magistrate, a committee of 18 was created. In Antwerp, Ghent, Ypres, etc., a committee of 18 was also created, closely connected with the consistories. Taking advantage of the favorable situation, William of Orange arrived in Brussels in September 1577 and, with the help of his supporters, succeeded in being elected as the ruvard (extraordinary viceroy) of Brabant.

The nobles, dissatisfied with the policies of William of Orange, invited Archduke Matthew, brother of the German Emperor Rudolf II, to the Netherlands. However, on October 28, 1577, the city plebs in Ghent revolted and arrested Duke Arschot and other nobles who had invited Archduke Matthew to the Netherlands. However, on November 12, 1577, the States – General officially recognized Archduke Matthew as governor – general of the provinces. Instead of deposing Archduke Matthew, the Committee of 18 in Brussels, at the instigation of the Orangeists, demanded that William of Orange be appointed as vice – archduke. In January 1578, the Estates – General granted this request.

Seeing that the army of the Estates – General was not in goog condition, Don Juan marched on them and defeated them on January 31, 1578. Due to the defeat, the leader of the nobility, Count F. De Lalin, was dismissed from his post as commander – in – chief, and some reactionary nobles were expelled from the army. Decisive measures were taken to defend the cities. The northern provinces intensified their attak on the last Spanish stronghold in the Netherlands, Amsterdam, and in February 1578 the city surrendered.

The States – General and William of Orange continued to seek military assistance abroad to maintain their rule. According to the treaty signed between the

States – General and England on 7 January 1578, the States – General pledged to give England the cities of Vlissingen, Middelburg, Bruges and Granville as hostages in exchange for financial and military aid. The treaty also provided for the possibility of an agreement between the States – General and Philip II.

France was also eager to get its share of the Dutch pie. At the invitation of William of Orange, the States – General, and his party of nobles, Francis of Anjou invaded the country with his troops in May 1578 under the guise of defender of the Netherlands. In return, the Duke of Anjou was promised some estates in the Netherlands. England, not wanting France to gain a foothold in the Netherlands, provided money to Palatine John Casimir, who in August 1578 sent his troops to the Netherlands.

Foreign mercenaries engaged in robbery and violence rather than fighting, while highly titled adventurers negotiated with the Spanish and surrendered cities to them. The massed of the people fought and rioted against them, as well as against the local nobility, the wealthy, and especially against the Catholic Church. The Catholic nobility demanded that William of Orange "restrain the depraved black people" and threatenned to side with the Spanish.

CONCLUSİONS

The first two phases of the Dutch Revolution cover the period from the İconoclast revolt to the conclusion of the Union of Utrecht. The equating of iconoclasm with vandalism was first proposed in 1794 by Bishop Henri Gregoire during the French bourgeois revolution, while analyzing the actions of the revolutionary army [4, 471- 488].

✓ This process can also be found in the leading countries of Europe. In England iconoclasm has been observed since the 20s and 30s of the 16th century. The rulers Edward VI, Elizabeth I, and prominent public figures Thomas Granmer and Thomas Gromwell played an important role in this process. The act against all offensive images adopted in 1547 and the return of Protestants expelled during the reign of Quenn Mary further strengthened this process.

✓ We encounter their activity not only in the beginning of the Dutch Revolution, but also in the serious changes that took place in England in the 16th century and the French Revolution of the 18th century.

✓ Iconoclasm is a social, cultural, political, or religious belief that the destruction of icons, images, statues, structures, and more broadly any work of art is a valid concern, and continues to this day. In modern times, iconoclasm is used to refer to individual acts of vandalism against cultural objects. At the same time, it also exists as a distinct cultural practice expressing a protest against the aesthetic heritace of previous eras. The political manifestations of iconoclasm in modern times have been reflected in the destruction of the World Trade Center towers in New York (2001), the destruction of the Buddha statues in Bamiyan by the Taliban (2001), etc. [8].

✓ The Iconoclast Revolt (1566) showed that the people were extremely dissatisfied with the policies of the Spanish monarchy and the Catholic Church.

✓ The widespread rebellion in the Netherlands led the Spanish to establish the terrorist regime of the Duke of Alba (1567 – 1573). The regime`s ruthless, harsh, and unrealistic policies led to the further strengthening of the resistance.

✓ The rebellion in the northern provinces of the Netherlands led to the formation of a strong resistance movement. The Revolt of the Sea Eyes (1572) resulted in the liberation of some of the northern provinces (Holland, Zeeland).

✓ The representative bodies of these states (the Supreme Estates) recognized William of Orange as their stadtholder (representative), laying the foundation for the future state.

✓ As the Spanish armies and the Calvinists fought, William of Orange realized that unity was needed for the opposition to succeed, and that the role of mediator had to be abandoned. Only the Calvinists could defend a strong opposition.

✓ There is no evidence that William had ever planned a revolution. However, the arrival of Duke Alba in the Netherlands in September 1567 and the atrocities he committed changed William`s mind. The prince`s manifestos clearly stated the need to protect the people from "torture, execution and suffering".

✓ The conclusion of the Pacification of Ghent (1576) is connected with the "incidents" committed by the Spaniards in Antwerp during the Dutch bourgeois revolution. The incident committed in Antwerp caused the southern provinces to join the rebellion. The agreement concluded between the Northern and Southern provinces was directed against the Spaniards. However, this agreement did not have strong foundations.

✓ During the Dutch Revolution, the country was effectively divided into two parts. The Catholic nobility of the southern provinces (Wallonia) quickly seized power, resulting in peace with the Spanish king and the signing of the Union of Arras (1579). In response, the northern provinces concluded the Union of Utrecht (1579), laying the foundation for a future independent state.

✓ The foundation of an independent state was laid. The conclusion of the Union of Utrecht laid the foundation for the future United Provinces Republic. This meant the creation of an independent Dutch republic. The creation of this republic should be regarded as a desisive step towards the creation of the first independent bourgeois state in Europe.

Thus, in the first and second stages of the Dutch bourgeois revolution, the Netherlands was actually divided into two main parts. While the northern provinces gained their independence, the south reached a peace with Spanish rule. The study of the history of these stages is of great importance in terms of examining the historical events that took place in the Netherlands on the eve of the creation of the United Provinces Republic, a future independent, strong and bourgeois state governed by new rules.

References

1. Alizadeh, A. (2007). *Christianity: history and philosophy.* Baku: Abilov, Zeynalov and brothers.

2. Baelde, M. (1979). The Pacification of Ghent in 1576: Hope and Uncertainty in the Netherlands. *The Low Countries History Yearbook.* Martinus Nijhoff Publishers, pp.1 – 17.

3. Chapman, H. (2018). Iconoslasm and Later Prehistory. – Routledge.

4. Demandt A. Vandalism as seecular Iconoclasm. *Iconoclasm and Iconoclash.* — BRILL, 2007. — P. 471—488.

5. *History of the Middle Ages* (2010), Early Modern Times. Volume 2. Moscow: Moscow University Publishing House.

6. Humphreys Mike. Introduction: Context, Controversies, and Developing Perspectives. *A Companion to Byzantine Econoclasm. Brill`s Companions to the Christion Tradition. 99.* Leiden and Boston: Brill Publishers. 2021, 1 – 106.

7. Iconoclasm. Available at: az.wikipedia.org/wiki//%C4%Bokonobor%C3%A7uluq (accessed 27 September 2025).

8. Iconoclasm. Available at: en.wikipedia.org/wiki/iconoclasm. (accessed 8 December 2025).

9. Jaeger, O. (2006). *World History. The Middle Ages.* Moscow: AST.

10. James Birx, H. (2006). Encyclopedia of Anthropology, Vol.1, Sage Publication, US.

11.Lesnikov M. Goes in the fight for the independence of the Netherlands. Plamb.ru. Online library. Available at: http://www.plam.ru/hist/partizanskaja_borba_v_nacionalno_osvoboditelnyh_voinah_zapada/p3.php.

12. Mironov V.B. People and personality in history. Essays on the history of Russian and world culture. In three volumes. Vol.1. Moscow: Zvonnitsa – MQ, 2000. Available at: https://bdshi.uln.muzkult.ru/media/2018/09/17/1217315542/Narody_i_lichnosti_v_istorii._V_3-Kh_t.T.1_Mironov_V.B_2000_-640s.pdf (accessed 30 September 2025).

13. Reformation. Lutheran (Evangelical Church). Calvinism. Netherlands. Available at: https://expositions.nlr.ru/ex_manus/reformation/Netherlands.php (accessed 30 September 2025).

14. Second commandment. Available at: https://www.jesuschurch.by/cjc77.html (accessed 10 December 2025).

15. Shatokhina – Mordvintseva G.A. The Dutch Revolution of the 16th century. Available at: https://old.bigenc.ru/world_history/text/2265835 (accessed 4 December 2025).

16. Spraggon, J. (2003). Puritan Iconoclasm during the English Civil War. – The Boydell Press.

17. Volkova, Q. (2006). Alba, Fernando // *Educational Spanish – Russian linguistic and reginal dictionary – reference book.* Moscow: Graduate School.

18. Yurenev, Rostislav. I was a lamp. *Eisenstein in memories of contemporaries.* Moscow: Iskusstvo, 1974, p.275 – 284.

MEDICAL SCIENCES

VITAMIN D STATUS IN PREGNANT WOMEN AND ITS IMPACT ON NEWBORNS

Todorova M.
Department of Clinical Laboratory;
Medical University Varna, Bulgaria; Senior Lecturer
Gerova D.
Department of Clinical Laboratory;
Medical University Varna, Bulgaria; Professor
DOI: 10.5281/zenodo.18084100

ABSTRACT

Introduction: Vitamin D plays a key role in calcium–phosphorus metabolism, immune regulation, and normal fetal development. Vitamin D deficiency during pregnancy is common and has been associated with an increased risk of adverse obstetric and neonatal outcomes, including preterm birth (PTB) and low birth weight (LBW).

Aim: To evaluate vitamin D status in pregnant women and to investigate its association with the risk of preterm birth and low birth weight.

Materials and Methods: A prospective study was conducted between 2019 and 2021 in Varna, Bulgaria, including 259 pregnant women. Participants were divided into three groups: healthy pregnant women, women with gestational diabetes mellitus (GDM), and women with preeclampsia (PE). Demographic and clinical data, information on vitamin D intake, and serum 25-hydroxyvitamin D [25(OH)D] concentrations were collected. Serum 25(OH)D levels were measured using a validated LC–MS method. Associations between vitamin D status, gestational age at delivery, and neonatal birth weight were analyzed.

Results: Preterm birth occurred in 12.45% of newborns, with the highest incidence observed among women with PE. Low birth weight was recorded in 13.23% of newborns, again most frequently in the PE group. A statistically significant association was found between maternal vitamin D intake and neonatal birth weight ($p < 0.0001$). In women with PE and in healthy pregnant women, higher vitamin D intake and higher serum 25(OH)D levels were associated with a lower risk of PTB and LBW. Correlation analysis demonstrated a positive association between serum 25(OH)D concentrations and gestational age, particularly in women with PE.

Conclusion: The findings of this study support the hypothesis that inadequate vitamin D status during pregnancy is associated with an increased risk of preterm birth and low birth weight, especially among women with preeclampsia. Optimization of vitamin D status through adequate supplementation may represent a safe, accessible, and cost-effective strategy for improving perinatal outcomes. Further large-scale randomized controlled trials are required to confirm these findings and to establish clear clinical recommendations.

Keywords: vitamin D, 25(OH)D, pregnancy, outcomes.

INTRODUCTION

Vitamin D plays a crucial role in calcium-phosphorus metabolism, skeletal development, and immune regulation. During pregnancy, adequate maternal vitamin D levels are essential not only for the health of the mother but also for the proper growth and development of the fetus [1]. Numerous studies have identified a consistent and strong association between maternal vitamin D deficiency and adverse pregnancy and birth outcomes, including an increased risk of preeclampsia (PE), gestational diabetes mellitus (GDM), preterm birth (PTB), low birth weight (LBW), and postpartum complications [2, 3].

Despite the well-established importance of vitamin D during pregnancy, hypovitaminosis D remains highly prevalent worldwide – particularly in regions with limited sunlight exposure, inadequate dietary intake, or cultural practices that reduce skin exposure [4]. Newborns rely entirely on maternal stores and placental transfer of vitamin D, making maternal status a critical determinant of neonatal vitamin D sufficiency [5].

Given the crucial role of vitamin D in maternal and fetal health, recent research has increasingly focused on its potential impact on specific pregnancy outcomes – particularly PTB and LBW.

PTB continues to be the leading cause of neonatal mortality globally and the second most common cause of death in children under five years of age [6]. The etiology of PTB is multifactorial and complex, involving genetic, environmental, immunological, and nutritional factors. Among these, vitamin D deficiency during pregnancy has gained increasing attention due to its potential role in modulating immune responses and inflammation – mechanisms thought to contribute to the onset of preterm labor [7].

LBW remains a significant global public health concern due to its association with increased neonatal morbidity and long-term adverse health outcomes [8]. Multiple studies have explored the potential role of maternal vitamin D deficiency in the etiology of LBW, given vitamin D's essential functions in fetal growth and development [9].

AIM

The aim of this study is to evaluate the vitamin D status in pregnant women and investigate its potential association with neonatal outcomes, specifically the risk of PTB and LBW. By analyzing maternal serum 25-hydroxyvitamin D (25(OH)D) concentrations and supplementation during pregnancy and correlating

them with pregnancy outcomes, the study seeks to determine whether maternal vitamin D sufficiency can serve as a protective factor against these adverse events.

MATERIAL AND METHODS

The research is prospective in character and has taken place in the Diagnostic and Consulting Centre of "St Marina" University Hospital, Acibadem City Clinic Medical Center, Specialized Hospital for Obstetrics and Gynecology for Active Treatment "Prof. Dr D. Stamatov", and General Hospital for Active Treatment "St. Anna" in Varna, from 02.07.2019 to 31.12.2021. A total of 259 pregnant women had been included in the scientific research. They filled in a questionnaire card that contained demographic data and information connected to their life style, the course of previous pregnancies (if there were such) and their obstetric outcomes, as well as a family history.

All pregnant women included in the clinical trial after getting acquainted and signing the informed consent form are asked to fill in a survey card, under doctor's supervision who is a participant in the survey. It contains demographic data and information related to their style of life (diet, physical activity, administration of medicines and dietary supplements), data about previous pregnancies and obstetric results, family history.

The quantitative analyses of the circulating form of vitamin D in blood serum were tested in the Department of Biochemistry, Molecular Medicine and Nutrigenomics at the Faculty of Pharmacy, Medical University, Varna. To achieve this goal validated LC-MS method with UV detection for identification and quantitative analysis of 25(OH)D in blood serum was used.

RESULTS

A total of 259 pregnant women were enrolled in the study. Of these, 210 women (81.08%) were evaluated as outpatients, while 49 women (18.91%) were hospitalized and treated as inpatients for PE at the Specialized Hospital for Obstetrics and Gynecology for Active Treatment 'Prof. Dr. D. Stamatov', Varna. The average age of participants was 30.5 years (range 19 – 49 years).

The majority of participants were of Bulgarian origin (89.57%, n=232), resided in a large city (90.35%, n=234), were married (55.21%, n=143), and had attained higher education (56.37%, n=146). Most participants (94.20%, n=244) did not have concomitant chronic or non-systemic diseases. Based on their health status, participants were classified into three major groups:

Group I: Healthy pregnant women (n=167, 64.5%). Among them, 114 (68.3%) were in the second trimester and 53 (31.7%) in the third trimester.

Group II: Pregnant women with GDM (n=43, 16.6%). Of these, 26 (60.5%) were in the second trimester and 17 (39.5%) in the third trimester. GDM diagnosis was based on an OGTT with 75 g of glucose administered between the 24th and 28th GW, or at another time during pregnancy, following the IDF (2013) and WHO (2013) criteria.

Group III: Pregnant women with PE (n=49, 18.9%). Of these, 6 (12.2%) were in the second trimester and 43 (87.8%) in the third trimester. All diagnoses were based on established clinical criteria, and participants were hospitalized in the Department of Pregnancy Pathology at the same hospital.

Vitamin D Status and Risk of PTB

In the present study, 32 out of 257 newborns (12.45%) were delivered preterm, indicating a notable rate of PTB. The highest incidence was observed among pregnant women with PE, where 45.83% (n = 22) of cases resulted in PTB. In comparison, the prevalence was 6.98% (n = 3) among those with GDM and 4.21% (n = 7) in the healthy control group.

To evaluate the potential role of maternal vitamin D status in the occurrence of PTB, we initially analyzed the frequency of this complication in relation to vitamin D intake. Participants were categorized based on their reported intake of vitamin D from pharmaceutical preparations and/or dietary supplements as follows: no intake, intake below 600 IU/day, and intake above 600 IU/day (Table 1).

Table 1

Distribution of Pregnant Women by Gestational Age and Vitamin D Supplementation (Entire Cohort)

Gestational Age	No Intake N (%)	<600 IU/day N (%)	>600 IU/day N (%)	Total N (%)
>37 weeks	73 (32.4%)	101 (44.9%)	51 (22.7%)	225 (100%)
<37 weeks	12 (37.5%)	15 (46.9%)	5 (15.6%)	32 (100%)

The results presented in Table 1 indicate that a similar proportion of women who delivered at term and those who experienced PTB were supplemented with vitamin D at doses below the recommended minimum of 600 IU/day (44.89% vs. 46.88%, respectively). The proportion of women who did not receive any vitamin D supplementation was higher among those who delivered preterm compared to those who delivered at term (37.50% vs. 32.44%, respectively). Conversely, a greater proportion of women who delivered at term received adequate vitamin D supplementation (>600 IU/day) compared to those with PTB (22.67% vs. 15.62%, respectively). A non-parametric chi-square analysis was conducted to evaluate potential differences between the groups; however, no statistically significant association was found ($\chi^2 = 0.879$, $p = 0.645$).

We also investigated the vitamin D intake among women from the three main groups who experienced PTB. Based on the frequency distribution, we can conclude that among healthy pregnant women and those with PE, the likelihood of PTB is lower in those who received adequate vitamin D supplementation (>600 IU/day) compared to those who were either not supplemented or supplemented with a lower dose (<600 IU/day). This trend, however, was not observed in the group of women with GDM.

Using Spearman correlation analysis, we investigated the association of PTB in the three main study groups with both vitamin D intake and serum concentrations of 25(OH)D. The results of the analysis are presented in Table 2. A positive and moderately strong correlation was found between serum levels of 25(OH)D and gestational age in women with PE (rho=0.358, p=0.016), as well as between serum levels of 25(OH)D and vitamin D supplementation (rho=0.410, p=0.014). This indicates that the likelihood of PTB decreases with increasing vitamin D intake and serum levels of 25(OH)D. Among healthy pregnant women, an increasing risk of PTB was observed with decreasing vitamin D intake during pregnancy (rho=0.273, p=0.007), and a moderate correlation was found between vitamin D supplementation and serum 25(OH)D levels (rho=0.498, p<0.0001). In the group of women with GDM, a strong correlation was found between vitamin D supplementation and serum 25(OH)D levels (rho=0.848, p<0.0001), but the weakly increasing risk of PTB with decreasing vitamin D intake and serum levels of 25(OH)D did not reach statistical significance (rho=0.167, p=0.416 and rho=0.138, p=0.382, respectively).

Table 2

Spearman's Correlation Between Vitamin D Intake, Serum 25(OH)D and Pregnancy Duration by Group

Group	Variable	Normal Gestation/PTB	Vitamin D Intake	Serum 25(OH)D nmol/l
Healthy Pregnant Women	Normal Gestation/PTB	1.000	0.273**	0.052
	Vitamin D Intake	0.273**	1.000	0.498**
	Serum 25(OH)D (nmol/l)	0.052	0.498**	1.000
	p-value	.	0.007	0.524
Women with GDM	Normal Gestation/PTB	1.000	0.167	0.138
	Vitamin D Intake	0.167	1.000	0.848**
	Serum 25(OH)D (nmol/l)	0.138	0.848**	1.000
	p-value	.	0.416	0.382
Women with PE	Normal Gestation/PTB	1.000	0.314	0.358*
	Vitamin D Intake	0.314	1.000	0.410*
	Serum 25(OH)D (nmol/l)	0.358*	0.410*	1.000
	p-value		0.055	0.016

Vitamin D Status and Risk of LBW

We used a similar approach to assess the influence of vitamin D status in pregnant women on LBW. Table 3 shows the frequency distribution of pregnant women based on vitamin D supplementation and the birth weight of their newborns for the entire studied cohort.

Table 3

Frequency Distribution of Pregnant Women Based on Vitamin D Supplementation and the Birth Weight of Their Newborns for the Entire Studied Cohort

Birth Weight	No Vitamin D Supplementation N (%)	Vitamin D Supplementation <600 IU/day N (%)	Vitamin D Supplementation >600 IU/day N (%)	Total N (%)
Normal Weight (>2500g)	58 (26.00%)	113 (50.67%)	52 (23.32%)	223 (100%)
Low Weight (<2500g)	27 (79.41%)	5 (14.70%)	2 (5.88%)	34 (100%)

Results presented in Table 3 show that the percentage of non-supplemented women who delivered a LBW infant is three times higher than that of women who delivered a newborn with normal weight (79.41% vs. 26.00%, respectively). Among those supplemented with vitamin D at doses <600 IU/day, the ratio is reversed – there is a 3.45-fold decrease in the percentage of LBW deliveries (50.67% vs. 14.70%). In women who received adequate supplementation (>600 IU/day), the percentage drops nearly fourfold (23.32% vs. 5.88%). A chi-square test confirmed that the distribution shown in Table 3 is statistically significant ($\chi^2 = 38.02$, $p < 0.0001$).

We also analyzed the vitamin D intake among women from the three main groups who gave birth to LBW infants. Based on their frequency distribution, we

can conclude that among healthy pregnant women and those with PE, the likelihood of delivering a LBW infant is lower in those who were supplemented with an adequate dose of vitamin D (>600 IU/day) compared to those who were either not supplemented or supplemented with a low dose of vitamin D (<600 IU/day). This trend was not observed in the group of women with GDM.

We also compared the mean values for vitamin D intake and serum 25(OH)D levels between pregnant women who delivered normal-weight infants and those who delivered LBW infants using an independent samples t-test (Table 4).

Table 4

Comparison of mean values of vitamin D intake and serum 25(OH)D concentrations in women who delivered normal weight vs. LBW newborns (entire cohort)

	Birth Weight	Mean ± SD	95% CI	*t*-test (*p*)
Vitamin D intake (IU/day)	Normal	824.26 ± 2167.65	[–58.7; 11.98]	$t = 0.667$, $p = 0.506$
	LBW	525.00 ± 810.39		
25(OH)D (nmol/L)	Normal	76.17 ± 38.33	[–13.22; 14.94]	$t = 0.121$, $p = 0.904$
	LBW	75.31 ± 40.40		

It is notable that the mean vitamin D intake was lower (525 ± 810.39 IU/day) among women who delivered a LBW infant compared to those who gave birth to a newborn with normal weight (824.26 ± 2167 IU/day), and it falls below the recommended minimum intake of 600 IU/day. Nevertheless, the comparative analysis did not reveal a statistically significant difference in the mean intake values between the two groups ($t = 0.667$, $p = 0.506$), likely due to the large standard deviation. No statistically significant difference was found in the serum 25(OH)D levels between the two groups either (76.17 ± 38.33 vs. 75.31 ± 40.40, $t = 0.121$, $p = 0.904$).

DISCUSSION

1. PTB

A growing body of literature has explored the association between maternal vitamin D status and the risk of PTB; however, findings remain inconsistent. Agarwal et al. (2018) proposed that insufficient vitamin D levels during gestation may suppress immune function and alter the pathophysiological pathways leading to PTB [10]. Nevertheless, a meta-analysis conducted by Lian et al. (2021) did not find a statistically significant correlation between vitamin D deficiency in any trimester and the risk of PTB. Specifically, 13 out of the 24 observational studies included in the analysis reported no association between low maternal 25(OH)D concentrations and PTB [11].

Contradictory evidence also exists. Several studies have demonstrated a clear link between low maternal vitamin D levels and an increased risk of PTB [12, 13]. Moreover, sufficient maternal vitamin D status – commonly defined as serum 25(OH)D levels above 100 nmol/L – has been associated with a 60% reduction in the risk of PTB [10].

In our study, the incidence of PTB was 12.45%, with 32 of 257 newborns delivered before term. Notably, two-thirds of these cases occurred in women diagnosed with PE, a known risk factor for PTB. Within the PE group, we observed the strongest association between vitamin D status and PTB. This group also demonstrated the lowest levels of vitamin D supplementation (with 57.14% reporting no intake) and the lowest serum 25(OH)D concentrations (median: 53.80 nmol/L, IQR: 42.23–67.05 nmol/L). These findings underscore the potential relevance of maternal vitamin D status in the pathogenesis of PTB, particularly among women with pre-existing pregnancy complications such as PE.

Additional studies support these observations. Bodnar et al. (2014) reported that nearly half of women who delivered preterm had 25(OH)D levels below 75 nmol/L [9]. Similarly, Agarwal et al. (2018) and McDonell et al. (2017) observed a markedly reduced risk of PTB in mothers with sufficient vitamin D levels (>100 nmol/L) [10, 14]. Despite these promising findings, not all studies are in agreement. For instance, Baker et al. (2011) found no statistically significant difference in vitamin D levels between women who delivered at term and those who experienced PTB between 23 and 35 weeks of gestation [15].

These discrepancies may be attributed to differences in study design, population characteristics, definitions of vitamin D sufficiency, and methods of 25(OH)D measurement. The heterogeneity of these factors complicates direct comparison and underscores the necessity for well-designed randomized controlled trials (RCTs) to confirm causality and inform clinical guidelines.

2. LBW

Several biological mechanisms have been proposed to explain how maternal vitamin D status may influence neonatal birth weight. One hypothesis suggests that low maternal serum 25(OH)D concentrations impair fetal skeletal growth and mineralization, leading to reduced birth weight. Another postulated mechanism involves vitamin D's anti-inflammatory properties and its role in modulating placental function. In this context, vitamin D deficiency may contribute to placental inflammation, thereby increasing the risk of intrauterine growth restriction (IUGR) and LBW [16, 17].

Additionally, vitamin D has been linked to the regulation of insulin-like growth factor 1 (IGF-1), a hormone involved in fetal growth signaling. Evidence from adult populations suggests that vitamin D supplementation increases IGF-1 levels, implying that maternal deficiency could lead to impaired fetal growth through this pathway [16]. Despite these plausible mechanisms, the existing literature presents conflicting findings. While some studies have demonstrated a positive correlation between maternal 25(OH)D levels and

neonatal birth weight [18], others have reported no significant association [19].

Our study found an overall incidence of LBW of 13.23% (n = 34), with the highest prevalence observed in women with PE – 33.33% (n = 16). In comparison, LBW rates among participants with gestational diabetes mellitus (GDM) and healthy pregnancies were 13.95% (n = 6) and 7.23% (n = 12), respectively. A significant association was identified between maternal vitamin D intake and neonatal birth weight ($\chi^2 = 38.02$, $p < 0.0001$), particularly among women with PE and healthy participants.

Although the difference in mean daily vitamin D intake between mothers of normal-weight (824.26 ± 2167.65 IU/day) and LBW infants (525.00 ± 810.39 IU/day) did not reach statistical significance – likely due to the wide variability in supplement dosages - it may still indicate a clinically meaningful trend. Similarly, no statistically significant difference was found in serum 25(OH)D concentrations between the two groups (76.17 ± 38.33 nmol/L vs. 75.31 ± 40.40 nmol/L; $p = 0.904$). This lack of significance could be due to confounding factors such as seasonality, sun exposure, diet, and physical activity, which were not controlled for in the current analysis. The relatively small number of LBW cases also limited our ability to perform stratified analyses and identify the most influential variables.

The inconsistent findings in our study mirror the broader literature, where randomized controlled trials have yielded mixed results. Nevertheless, the majority of systematic reviews and meta-analyses - such as the one conducted by Maugeri et al. (2019) – suggest a positive effect of maternal vitamin D supplementation on neonatal birth weight [20]. These findings support the hypothesis that optimizing vitamin D status during pregnancy may be a simple and cost-effective strategy for improving fetal growth and reducing the risk of LBW.

CONCLUSION

The present study supports the hypothesis that vitamin D deficiency during pregnancy may be associated with an increased risk of adverse outcomes such as PTB and LBW. Although a statistically significant causal relationship was not consistently demonstrated, the observed correlations between vitamin D intake, serum 25(OH)D levels, and the occurrence of these complications highlight the potential role of this micronutrient in maintaining a healthy pregnancy.

Historically, vitamin D supplementation has led to one of the most significant achievements in public health – the global elimination of rickets. In the modern context, attention has shifted toward the exploration of vitamin D's non-calcemic effects, including its impact on immune regulation, inflammation, and placental function. This is particularly relevant in vulnerable populations such as pregnant women and newborns.

Lifestyle modifications, combined with timely identification and correction of vitamin D deficiency, could represent an effective, accessible, and low-risk strategy for improving perinatal outcomes and promoting long-term maternal and child health. However, further randomized controlled trials with larger cohorts are needed to confirm the observed trends and to develop clear clinical recommendations.

References

1. Bärebring L, Bullarbo M, Glantz A, Leu Agelii M, Jagner Å, Ellis J, et al. High prevalence of vitamin D deficiency in Swedish pregnant women. *Acta Obstet Gynecol Scand*. 2016;95(11):1165–72.
2. Dovnik A, Mujezinović F. The association of vitamin D levels with common pregnancy complications. *Nutrients*. 2018;10(7):867.
3. Hayden MH, Sachs BP, Makari-Judson G, Zera C, Holick MF. Vitamin D deficiency and gestational disorders in pregnancy: a review. *J Midwifery Womens Health*. 2018;63(5):545–56.
4. Cashman KD, Dowling KG, Škrabáková Z, Gonzalez-Gross M, Valtueña J, De Henauw S, et al. Vitamin D deficiency in Europe: pandemic? *Am J Clin Nutr*. 2016;103(4):1033–44.
5. Dror DK, Allen LH. Vitamin D inadequacy in pregnancy: biology, outcomes, and interventions. *Nutr Rev*. 2010;68(8):465–77.
6. WHO antenatal care recommendations for a positive pregnancy experience. Nutritional interventions update: multiple micronutrient supplements during pregnancy. Geneva, Switzerland: World Health Organization; 2020
7. Wagner, CL, Hollis, BW (2012). Vitamin D and pregnancy: skeletal effects, nonskeletal effects, and birth outcomes. *Calcified Tissue International*, 91(2), 128–139. https://doi.org/10.1007/s00223-012-9607-4
8. World Health Organization. (2014). *Global nutrition targets 2025: low birth weight policy brief*. Geneva: WHO. https://www.who.int/publications/i/item/WHO-NMH-NHD-14.5
9. Bodnar LM, Platt RW, Simhan HN. Early-pregnancy vitamin D deficiency and risk of preterm birth subtypes. *Obstet Gynecol*. 2014;123(3): 527–35.
10. Agarwal N, Mithal A, Dhingra V, et al. Impact of maternal vitamin D deficiency on pregnancy and its outcomes: a prospective cohort study. *Gynecol Endocrinol*. 2018;34(10):853–6.
11. Lian RH, Qi PA, Yuan T, et al. Systematic review and meta-analysis of vitamin D deficiency in different pregnancy on preterm birth: Deficiency in middle pregnancy might be at risk. Medicine (Baltimore). 2021 Jun 18;100(24)
12. Baczyńska-Strzecha M, Kalinka J. Assessment of correlation between vitamin D level and prevalence of preterm births in the population of pregnant women in Poland. Int J Occup Med Environ Health. 2017 Oct 6;30(6):933-941.
13. Kassai MS, Cafeo FR, Affonso-Kaufman FA, Suano-Souza FI, Sarni ROS. Vitamin D plasma concentrations in pregnant women and their preterm newborns. BMC Pregnancy Childbirth. 2018 Oct 22;18(1):412. doi: 10.1186/s12884-018-2045-1. PMID: 30348112; PMCID: PMC6198501.
14. McDonnell SL, Baggerly KA, French CB, et al. Maternal 25(OH)D concentrations ≥100 nmol/L are associated with 60% lower risk of preterm birth in a cohort of more than 1,000 US pregnant women. *Nutrients*. 2017;9(8):876.

15. Baker AM, Haeri S, Camargo CA Jr, Espinola JA, Stuebe AM. A nested case-control study of midgestation vitamin D deficiency and risk of severe preeclampsia. *J Clin Endocrinol Metab*. 2011;95(11):5105–9.

16. Chen YH, Fu L, Hao JH, Yu Z, Zhu P, Wang H, et al. Maternal vitamin D deficiency during pregnancy elevates the risks of small for gestational age and low birth weight infants in Chinese population. *J Clin Endocrinol Metab*. 2015;100(5):1912–9.

17. Chen YH, Zhu P, Wang H, Hao JH, Tao RX, Xu YH, et al. Does vitamin D affect insulin resistance and IGF-1 levels in pregnant women? A longitudinal cohort study. *Clin Nutr*. 2017;36(2):485–90.

18. Morgan H, Roberts SA, Dixon PH, Peacock JL, Rees DA, Hattersley AT, et al. Maternal vitamin D status in pregnancy and offspring bone mass at birth: the Southampton Women's Survey. *J Clin Endocrinol Metab*. 2016;101(3):1056–64.

19. Almidani E, Albuali W, Ashmawi R, et al. Vitamin D level and its relation to birth weight in neonates: a prospective study. *Pediatr Rep*. 2021;13(3):381–8.

20. Maugeri A, Barchitta M, Blanco I, Agodi A. Effects of Vitamin D Supplementation During Pregnancy on Birth Size: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Nutrients. 2019 Feb 20;11(2):442.

КОСТНО-МЫШЕЧНЫЕ ПРОЯВЛЕНИЯ ПРИ ОРФАННЫХ ЗАБОЛЕВАНИЯХ

Абдуллаева М.Т.,
АО «Научно-исследовательский институт кардиологии и внутренних болезней», Республика Казахстан, г. Алматы
Казахский национальный медицинский университет им. С.Д. Асфендиярова, Республика Казахстан. г.Алматы
Валиева А.Е.,
АО «Научно-исследовательский институт кардиологии и внутренних болезней», Республика Казахстан, г. Алматы
Есентай М.,
АО «Научно-исследовательский институт кардиологии и внутренних болезней», Республика Казахстан, г. Алматы
Дилдаш М.М.,
Казахский национальный медицинский университет им. С.Д. Асфендиярова, Республика Казахстан. г.Алматы
Смаил М.А.
АО «Научно-исследовательский институт кардиологии и внутренних болезней», Республика Казахстан, г. Алматы

MUSCULOSKELETAL MANIFESTATIONS IN RARE (ORPHAN) DISEASES

Abdullaeva M.
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Research Institute of Cardiology and Internal Medicine, Almaty, Kazakhstan
Valiyeva A.
Research Institute of Cardiology and Internal Medicine, Almaty, Kazakhstan
Esentay M.
Research Institute of Cardiology and Internal Medicine, Almaty, Kazakhstan
Dildash M.
Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan
Smail M.
Research Institute of Cardiology and Internal Medicine, Almaty, Kazakhstan
DOI: 10.5281/zenodo.18084419

АННОТАЦИЯ

Актуальность: Костно-мышечные проявления при орфанных заболеваниях, таких как болезнь Фабри (БФ) и мукополисахаридозы (МПС), часто приводят к значительной инвалидизации пациентов. Ранняя диагностика и своевременная терапия позволяют замедлить прогрессирование поражений костно-мышечной системы, улучшая качество жизни. Изучение данных проявлений необходимо для повышения настороженности врачей и оптимизации тактики ведения пациентов.

Цель:

Изучить костно-мышечные проявления болезни Фабри и Мукополисахаридоза, их диагностику и влияние на функциональное состояние пациентов.

Материал и методы:

Анализ клинических случаев, литературных данных и рентгенологических исследований пациентов с болезнью Фабри и МПС.

Результаты:

При болезни Фабри выявляются миалгии, артралгии, остеопения.

При МПС – деформации костей, контрактуры суставов, гипомобильность.

Выводы:

Скелетно-мышечные проявления существенно ухудшают качество жизни пациентов. Ранняя диагностика и специализированная терапия необходимы для коррекции осложнений.

ABSTRACT

Relevance:

Musculoskeletal manifestations in orphan diseases such as Fabry disease and mucopolysaccharidoses (MPS) often lead to significant patient disability. Early diagnosis and timely therapy can slow the progression of musculoskeletal system involvement, improving quality of life. Studying these manifestations is necessary to increase physician awareness and optimize patient management strategies.

Materials and Methods: Analysis of clinical cases, literature data, and radiological studies of patients with Fabry disease and MPS.

Results: In Fabry disease, myalgia, arthralgia, and osteopenia were identified. In MPS, bone deformities, joint contractures, and hypomobility were observed.

Conclusions: Musculoskeletal manifestations significantly worsen the quality of life of patients. Early diagnosis and specialized therapy are necessary to manage complications effectively.

Ключевые слова: болезнь Фабри, сфинголипидоз, α-галактозидаза, скелетно-мышечные проявления, аутовоспаление, мультисистемность, Мукополисахаридоз, ген IDS, идуронат-2-сульфатаза, фермент-заместительная терапия.

Keywords: Fabry disease, sphingolipidosis, α-galactosidase, musculoskeletal manifestations, autoinflammation, multisystem involvement, mucopolysaccharidosis, IDS gene, iduronate-2-sulfatase, enzyme replacement therapy.

Введение:

Наследственный сфинголипидоз Фабри–Андерсена относится к орфанным лизосомальным болезням накопления. Описанный двумя учеными-дерматологами Андерсеном и Фабри в 1898г., он характеризуется Х-сцепленным типом наследования, гетерогенностью и мультистемностью поражения, что требует вовлечения в диагностику заболевания многих специалистов, в том числе ревматологов. Немало научных исследований описывают наличие у пациентов с болезнью Фабри (БФ) скелетно-мышечных болей, которые имитируют акропарестезии вследствие отложения сфинголипидов в периферических нервных окончаниях. Нарушение метаболизма сфинголипидов связано с мутацией гена *GLA* и нарушением синтеза фермента α-галактозидазы (α-Gal A), которая нужна для их расщепления. В результате недостаточной выработки α-Gal A в органах и тканях накапливаются продукты обмена в виде глоботриаозилцерамидов, которые аккумулируются в сосудистом эндотелии, коже, гладкомышечных клетках, невральных клетках головного мозга, ганглиях, подоцитах почек, мезангиальных и канальцевых клетках, сердечной мышце и клетках проводящей системы сердца. Этим и обусловлена полиорганность поражения при БФ, при этом превалирование клинического синдрома или дебют поражения зависят от наличия определенной мутации гена *GLA*, обусловливающей преобладающий фенотип развития картины заболевания. Характерными прояв- лениями являются поражения жизненно важных органов: почек, сердца, головного мозга, характеризующие тяжесть и прогноз сфинглипидоза. Костно-мышечные симптомы в виде артралгий, акропарестезий, лихорадки, сосудистых расстройств по типу синдрома Рейно, поражения кожи в виде специфических ангиокератом, поражение почек, наличие вихревидной кератопатии уводит врачей общего звена в сторону поиска системных иммуновоспалительных заболеваний, особенно у детей и подростков, что удлиняет «окно возможностей» для своевременной диагностики БФ до 10–15 лет и приводит к необратимым исходам. Это стимулирует генетиков и клинических исследователей проводить ранний скрининг на БФ пациентов из групп семейного риска, а также находящихся на заместительной почечной терапии, с гипертрофической кардиомиопатией и инсультами у молодых пациентов. В практику внедряется неонатальный скрининг на БФ. Если ранее считалось, что все клинические проявления обусловлены только накоплением субстрата и вызываемым им фиброзом органов и тканей, то в настоящее время доказана роль аутовоспаления в прогрессировании клинических проявлений БФ. Накопление гликосфинголипидов в сосудистом эндотелии вызывает активацию хронического воспаления в виде оксидативного стресса, повышение 3-нитротирозина как маркера васкулопатии, что приводит к пролиферации эндотелия, повышению трансформирующего фактора роста β, превращению мезенхимальных клеток в фиброзные и формированию тотального интерстициального фиброза. Это вызывает повышение острофазовых маркеров воспаления – высокочувствительного С-реактивного белка (СРБ), провоспалительных цитокинов при отсутствии подтверждающих органоспецифических аутоантител. Кроме того, БФ сейчас рассматривают как аутовоспалительный синдром с криопиринзависимым механизмом патогенеза, в основе которого лежит выработка инфламмасом. Это приводит к выработке каскада цитокинов воспаления – интерлейкинов-1β, 6, 8, фактора некроза опухоли α, выработка которых увеличивается с течением времени, вызывая необратимые изменения со стороны жизненно важных органов и систем.

Мукополисахаридозы – мультисистемное заболевание с многообразными проявлениями со стороны опорно-двигательного аппарата, нервной системы, внутренних органов, зрения и слуха и др. В зависимости от тяжести клинической симптоматики выделяют тяжелую (60–75% случаев) и легкую формы болезни. Основным критерием разграничения служит наличие или отсутствие прогрессирующего поражения ЦНС. Ряд авторов указывает на континуум полиорганных симптомов МПС от очень тяжелых до относительно легких фенотипов, отмечая, что и при легких формах постепенно происходит вовлечение ЦНС в патологический процесс. Проблема своевременной диагностики заболевания стала особенно актуальной после появления методов патогенетического лечения. Ферментозаместительная терапия в настоящее время остается единственным патогномоничным методом, существенно облегчающим состояние пациентов. Обсуждается эффективность этого вида лечения. Представлены возможности, ограничения и перспективы трансплантации гемопоэтических стволовых клеток и других способов лечения.

Цель: Описать костно-мышечные проявления болезни Фабри и Мукополисахаридозе, их диагностику и влияние на функциональное состояние пациентов.

Материалы и методы:

Анализ клинических случаев, литературных данных с БФ и МПС.

Полиорганность поражения при БФ, при этом превалирование клинического синдрома или дебют поражения зависят от наличия определенной мутации гена GLA, обусловливающей преобладающий

фенотип развития картины заболевания. Характерными проявлениями являются поражения жизненно важных органов: почек, сердца, головного мозга, характеризующие тяжесть и прогноз сфинглипидоза. Костно-мышечные симптомы в виде артралгий, акропарестезий и других органов, особенно у детей и подростков, что удлиняет «окно возможностей» для своевременной диагностики БФ до 10–15 лет и приводит к необратимым исходам.

МПС – мультисистемное заболевание с многообразными проявлениями со стороны опорно-двигательного аппарата, нервной системы, внутренних органов, зрения и слуха и др. Проблема своевременной диагностики заболевания стала особенно актуальной после появления методов ферментзаместительной терапии

Результаты:

При БФ выявляются миалгии, артралгии, остеопения.

Костно-мышечные проявления БФ описаны многими исследователями. Так, по данным O. Lidove и соавт., БФ часто является причиной скелетно-мышечных симптомов, наиболее распространенными из которых являются боли в конечностях и остеопороз. По их наблюдениям пациенты с БФ страдали асептическими аваскулярными некрозами конечностей, остеопоротическими переломами, тендовагинитами. По данным российских исследователей С.В. Моисеева и соавт., ревматологические «маски» БФ наблюдались у 26,8% из 82 исследуемых пациентов: васкулиты (7,3%), артрит (6,1%), болезнь Рандю–Ослера (4,9%), ревматическую лихорадку (4,9%), СКВ (3,7%), периодическую болезнь (1,2%). R. James и соавт. описывают многочисленные случаи поздней диагностики БФ у детей, протекающей под «маской» ювенильного ревматоидного артрита.

При МПС – деформации костей, контрактуры суставов, гипомобильность.

При МПС имеются деформация костей черепа, гаргоилизм, короткая шея, грубые черты лица - выступающие лобные бугры, вдавление носовой перегородки, мелкие и редкие зубы. Воронкообразная деформация грудной клетки. Сгибательная контрактура локтевых суставов, разгибательная контрактура межфаланговых суставов кистей рук, сгибательные контрактуры пальцев в виде «когтистой лапы»; тугоподвижность в тазобедренных суставах Ограничения движения и деформации в коленных суставах, ограничение сгибании с обеих сторон. Укорочение и смещение обеих стоп в продольном и поперечном направлений.

Для диагностики при БФ и МПС используют молекулярно-генетические анализы и конечно же, рентгенологические обследования пораженных суставов.

Заключение:

Болезнь Фабри и Мукополисахаридоз, относятся к орфанным заболеваниям, которые характеризуются полиорганностью и мультисистемностью. Лизосомальные болезни накопления поражают органы и ткани вследствие отложения субстратов обмена сфинголипидов. Одними из клинических признаков дебюта болезни Фабри являются ревматологические костно-мышечные проявления, лихорадка, ангиокератомы, напоминающие гемаррагическую сыпь, при этом не происходит органического поражения и деструкции суставов, а данные проявления лишь имитируют системные проявления и являются ревматологическими «масками» БФ.

Одними из клинически значимых проявлений мукополисахаридозов являются поражения опорно-двигательного аппарата в виде сгибательных контрактур, тугоподвижности, вторичных дегенеративных изменений без экссудативных проявлений, которые снижают качество жизни пациентов, требуют реабилитации, наблюдения ревматолога, реабилитолога. Кроме этого, поражения клапанного аппарата сердца требуют настороженности в плане вторичных инфекционных осложнений.

Скелетно-мышечные проявления существенно ухудшают качество жизни пациентов. Таким образом, наряду с пожизненной ферментозаместительной терапией, пациенты с болезнью Фабри и мукополисахаридозами требуют мультидисциплинарного подхода и прежде всего, мониторинга со стороны ревматологов.

Раскрытие интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

Вклад авторов. Авторы декларируют соответствие своего авторства международным критериям ICMJE. Все авторы в равной степени участвовали в подготовке публикации: разработка концепции статьи, получение и анализ фактических данных, написание и редактирование текста статьи, проверка и утверждение текста статьи.

Источник финансирования. Авторы декларируют отсутствие внешнего финансирования для проведения исследования и публикации статьи.

Литература

1. Michaud M, Mauhin W, Belmatoug N, et al. When and how to diagnose Fabry disease in clinical practice. Am J Med Sci. 2020;3:1-9. DOI:10.1016/j.amjms.2020.07.011

2. Ortiz A, Germain GP, Desnick RJ, et al. Fabry disease revisited: management and treatment recommendations for adult patients. Mol Genet Metab. 2018;123(4):416-27. DOI: 10.1016/j.ymgme.2018.02.014

3. Arends M, Wanner Ch, Mehta A, et al. Characterization of Classical and Nonclassical Fabry Disease: A Multicenter Study. JASN. 2017;28(5):1631-41. DOI:10.1681/ASN.2016090964

4. Carnicer-Cáceres C, Arranz-Amo JA, Cea-Arestin C, et al. Biomarkers in Fabry Disease. Implications for Clinical Diagnosis and Follow-up. J Clin Med. 2021;10(8):1664. DOI:10.3390/jcm10081664

5. Тао Е.А., Моисеев А.С., Буланов Н.М., и др. Терминальная хрони- ческая почечная недостаточность у пациентов с болезнью Фабри. Клиническая фармакология и терапия. 2020;29(4):36-43 [Тао

E, Moiseev A, Bulanov N, et al. End-stage renal disease in patients with Fabry disease. Clin Pharmacol Ther. 2020;29(4):36-43 (in Russian)]. DOI:10.32756/0869-5490-2020-4-36-43

6. Моисеев С.В., Тао Е.А., Моисеев А.С., и др. Клинические прояв- ления и исходы болезни Фабри у 150 взрослых пациентов. Клиническая фармакология и терапия. 2021;30(3):43-51 [Moiseev S, Tao E, Moiseev A, et al. Clinical manifestations and outcomes of Fabry disease in 150 adult patients. Clin Pharmacol Ther. 2021;30(3):43-51 (in Russian)]. DOI:10.32756/0869-5490-2021-3-43-51

7. Моисеев С.В., Новиков П.И., Фомин В.В. Лечение болезни Фабри. Клиническая фармакология и терапия. 2016;25(4):63-70 [Moiseev SV, Novikov PI, Fomin VV. Treatment of Fabry disease. Clin Pharmacol Ther. 2016;25(4):63-70 (in Russian)].

8. Rosa Neto NS, Bento JCB, Pereira RMR. Higher rate of rheumatic manifestations and delay in diagnosis in Brazilian Fabry disease patients. Adv Rheumatol. 2020;60(1):7. DOI:10.1186/s42358-019-0111-7

9. Моисеев С.В., Новиков П.И., Буланов Н.М., и др. Болезнь Фабри в практике ревматолога. Клиническая фармакология и терапия. 2018;27(1):39-45 [Moiseev SV, Novikov PI, Bulanov NM, et al. Fabry disease in rheumatology practice. Clin Pharmacol Ther. 2018;27(1):39-45 (in Russian)].

10. Моисеев С.В., Каровайкина Е.А., Буланов Н.М., и др. Предикторы клинических исходов болезни Фабри: роль хронической болезни почек. Терапевтический архив. 2019;91(6):40-6 [Moiseev SV, Karovaikina EA, Bulanov NM, et al. Predictors of clinical events in patients with Fabry disease: the role of chronic kidney disease. Terapevticheskii Arkhiv (Ter. Arkh.). 2019;91(6):40-6 (inRussian)]. DOI:10.26442/00403660.2019.06.000251

11. Semyachkina AN, Voskoboeva EY, Nikolaeva EA, Baydakova GV. A case report of a female with a mild form of Hunter syndrome. J. Inherit. Metab. Dis. 2018; 41 (Suppl. 1): E223.

12. Ficicioglu C, Giugliani R, Harmatz P, Mendelsohn NJ, Jego V, Parini R. Intrafamilial variability in the clinical manifestations of mucopolysaccharidosis type II: Data from the Hunter Outcome Survey (HOS). Am. J. Med. Genet. A. 2018; 176 (2): 301–310.

13. Muenzer J, Giugliani R, Scarpa M, Tylki-Szymańska A, Jego V, Beck M. Clinical outcomes in idursulfase-treated patients with mucopolysaccharidosis type II: 3-year data from the hunter outcome survey (HOS). Orphanet J. Rare Dis. 2017; 12: 161. doi: 10.1186/s13023-017-0712-3.

14. Fecarotta S, Gasperini S, Parenti G. New treatments for the mucopolysaccharidoses: from pathophysiology to therapy. Ital. J. Pediatr. 2018; 44 (Suppl. 2): 124. doi: 10.1186/s13052- 018-0564-z.

15. Hoshina H, Shimada Y, Higuchi T, Kobayashi H, Ida H, Ohashi T. Chaperone effect of sulfated disaccharide from heparin on mutant iduronate-2-sulfatase in mucopolysaccharidosis type II. Mol. Genet. Metab. 2018; 123 (2): 118–122. doi: 10.1016/j. ymgme.2017.12.428.

МОРФОМЕТРИЧЕСКАЯ ОЦЕНКА ВЛИЯНИЯ ОКСИГЕНАЦИИ НА ПЛОСКОКЛЕТОЧНЫЙ РАК ШЕЙКИ МАТКИ

Бурмистров М.В.
ГАУЗ «РКБ МЗ РТ»
Иванов В.В.
ГБУ ДНР РОЦ им. проф. Г.В. Бондаря
Шумило И.О.
ГБУ ДНР РОЦ им. проф. Г.В. Бондаря
ФГБОУ ВО ДонГМУ Минздрава России

MORPHOMETRIC ESTIMATION OF OXYGENATION INFLUENCE ON SQUAMOUS CELL UTERINE CERVIX CARCINOMAS

Burmistrov M.
GAUZ "RCB of the Ministry of Health of the Republic of Tatarstan"
Ivanov V.
GBU DNR ROC named after Prof. G.V. Bondar
Shumilo I.
GBU DNR ROC named after Prof. G.V. Bondar
FSBEI HE DonGMU of the Ministry of Health of Russia
DOI: 10.5281/zenodo.18084440

АННОТАЦИЯ

Рак шейки матки является одним из самых распространенных онкологических заболеваний, при этом гипоксия опухоли находится на одном из самых высоких уровней. Показано, что именно гипоксия является основным фактором, влияющим на прогрессию опухолей и их устойчивость к химиолучевой терапии. **Цель** нашего исследования — оценить влияние оксигенации на размеры опухолевых клеток и их ядер, а также отношение стромы и паренхимы при плоскоклеточном раке шейки матки. В исследовании участвовало 53 пациентки с местно-распространенным плоскоклеточным РШМ IIb стадии. Всем пациенткам проводилась химиолучевая терапия. В дальнейшем все больные были разделены на две группы: 31 пациентке (опытная группа) проводили трансректальную инсуфляцию озон-кислородной смеси. Для этой цели использовали аппарат «Медозон-БМ» (Н. Новгород) с подачей озона на выходе 10 ц/ml на 1,5 л (суммарная доза 15 мг). Остальным 22 пациенткам (контрольная группа) инсуфляцию озон-кислородной смеси не проводили. Через три недели после химиолучевой терапии, всем пациенткам выполнили радикальную гистерэктомию. Операционный материал фиксировали в 10% нейтральном формалине. На парафиновых срезах окрашенных гематоксилин-эозином оценивали средний размер опухолевой клетки и ее ядра, а также отношение площади стромы опухоли к паренхиме. Под влиянием озон-кислородной смеси достоверно уменьшались размеры ядер и самих опухолевых клеток, а также отношение стромы к паренхиме опухоли.

Нами впервые проведена морфометрическая оценка эффективности повреждающего действия химиолучевой терапии на плоскоклеточный рак шейки матки при оксигенации ткани опухоли и показано, что оксигенация опухоли повышает эффективность химиолучевой терапии.

ABSTRACT

Cervical cancer is one of the most common cancers, with tumor hypoxia at one of the highest levels. It has been shown that hypoxia is the main factor influencing the progression of tumors and their resistance to chemoradiotherapy. The aim of our study was to evaluate the effect of oxygenation on the size of tumor cells and their nuclei, as well as the ratio of stroma and parenchyma in squamous cell carcinoma of the cervix. The study involved 53 patients with locally advanced stage IIb squamous cell carcinoma. All patients underwent chemoradiotherapy. Subsequently, all patients were divided into two groups: 31 patients (the experimental group) underwent transrectal insufflation of an ozone-oxygen mixture. For this purpose, the Medozon-BM device (Nizhny Novgorod) was used with ozone supply at the output of 10 c/ml per 1.5 liters (total dose of 15 mg). The remaining 22 patients (control group) were not insufflated with an ozone-oxygen mixture. Three weeks after chemoradiotherapy, all patients underwent radical hysterectomy. The surgical material was fixed in 10% neutral formalin. The average size of the tumor cell and its nucleus, as well as the ratio of the tumor stroma area to the parenchyma, were evaluated on paraffin sections stained with hematoxylin-eosin. Under the influence of the ozone-oxygen mixture, the size of the nuclei and the tumor cells themselves, as well as the ratio of the stroma to the tumor parenchyma, significantly decreased.

For the first time, we performed a morphometric assessment of the effectiveness of the damaging effect of chemoradiotherapy on squamous cell carcinoma of the cervix during oxygenation of tumor tissue and showed that tumor oxygenation increases the effectiveness of chemoradiotherapy.

Ключевые слова: плоскоклеточный рак шейки матки, гипоксия, оксигенация, морфометрия
Keywords: cervical cancer, radiochemotherapy, ozone-oxygen mixture.

Рак шейки матки является одним из самых распространенных онкологических заболеваний, при этом гипоксия опухоли находится на одном из самых высоких уровней [11, 15]. Показано, что именно гипоксия является основным фактором, влияющим на прогрессию опухолей и их устойчивость к химиолучевой терапии. Первые исследования влияния повышения оксигенации опухоли были предприняты в 70-х годах двадцатого столетия немецкими учеными [5, 6]. Использовалась методика внутривенного введения озонированной крови самих пациенток в комбинированном лечении рака шейки матки. Авторы отметили снижение осложнений лучевой терапии, более быстрый регресс опухоли и улучшение общего соматического состояния больных. В последующем работы в данном направлении по необъяснимым причинам ограничились лишь экспериментальными и клиническими исследованиями влияния гипоксии на прогрессирование опухоли при раке шейки матки [7]. В то же время в нескольких экспериментальных работах показана неэффективность внутривенного введения озона при карциноме Эрлиха, саркоме 180 и фибросаркоме NR-FS [11]. Наличие противоречивых данных требует дальнейших исследований условий оксигенации опухоли и применение адекватных критериев оценки эффективности.

Более 100 лет назад впервые было предложено использовать ядерно-цитоплазматическое отношение как постоянную величину, характеризующую каждый клеточный тип [1, 3]. Была описана прямая зависимость между размерами ядра, клетки, генома и плоидностью [4, 9, 11]. В последнее время публикуется большое количество работ, посвященных молекулярным механизмам изменения ядерно-цитоплазматического отношения. Одна из теорий предполагает, что на размер ядра определяет ядерный цитоскелет, который зависит от количества ДНК, степенью ее уплотнения и строение ядерных мембран [2, 4, 10].

Цель исследования — оценить влияние оксигенации на размеры опухолевых клеток и их ядер, а также отношение стромы и паренхимы при плоскоклеточном раке шейки матки.

Методика

В исследовании участвовало 53 пациентки с местно-распространенным плоскоклеточным РШМ IIb стадии. Возраст больных колебался от 24 до 63 лет (в среднем 42,2 года). Согласно международной клинической классификации РШМ FIGO (2002 года), в исследование были включены женщины со IIb стадией (T2bN0M0), при которой опухоль прорастала шейку матки с инвазией параметрия, но без распространения на близлежащие лимфатические узлы или отдаленные органы.

На первом предоперационном этапе лечения всем 53 пациенткам проводилась химиолучевая терапия (ХЛТ) по схеме принятой с 1997 года в НИИ онкологии им. Н.Н. Петрова (г. Санкт-Петербург). В дальнейшем все больные были разделены на две группы: 31 пациентке (58,5%) (основная группа) из 53 проводили трансректальную инсуфляцию озонкис- лородной смеси (ОКС) в качестве радиомодификатора перед каждым сеансом облучения. Для этой цели использовали аппарат Медозон-БМ (Н. Новгород) с подачей озона на выходе 10 ц/ml на 1,5 л (суммарная доза 15 мг).

Остальным 22 пациенткам (41,5%) (контрольная группа) мы провели предоперационную IIb стадии ХЛТ по вышеописанной схеме без применения ОКС. На втором этапе, через три недели после ХЛТ, всем 53 (100%) пациенткам выполнили радикальную гистерэктомию с двухсторонней подвздошной лимфаденэктомией по методу Вертгейма — Мейгса. Операционный материал фиксировали в 10% нейтральном забуференном формалине сроком на 24-48 часов при комнатной температуре.

В дальнейшем после сбора образцов ткани в пластмассовые кассеты многоразового использования Plastic Embedding Device (BioOptica, Италия) с соответствующей маркировкой, кассеты закладывали в аппарат автоматизированной вакуумной системы обработки тканей (Leica ASP 300,Германия) с целью обезвоживания материала в спиртах восходящей концентрации по заданной программе. После спиртов проводку материала продолжали в ксилолах при температуре 37°С и пропитывали парафином. Заливку материала выполняли при помощи заливочного центра (Leica EG 1160, Германия). Срезы с парафиновых блоков выполняли серийно на ротационном микротоме (Leica RM 2125 RT, Германия) толщиной 3-5 мкм. Гистологические стекла изучали с помощью универсального микроскопа Olympus BX51WI. Использовали объектив Olympus LMPlanFl 20x/0.40. В каждом микропрепарате анализировали десять произвольных полей зрения, в которых видны опухолевые клетки. Для анализа изображений использовали программу Adobe Photoshop.

На парафиновых срезах окрашенных гематокси- лин-эозином оценивали средний размер опухолевой клетки и ее ядра (рис. 1). Для получения средних значений измеряли наибольший и наименьший размер каждой клетки. Сумму полученных значений делили на два. Аналогично для каждой анализируемой клетки подсчитывали размер ядра. Подсчет отношения площади стромы опухоли к паренхиме осуществляли с использованием объективов малого увеличения (х10) (рис. 2).

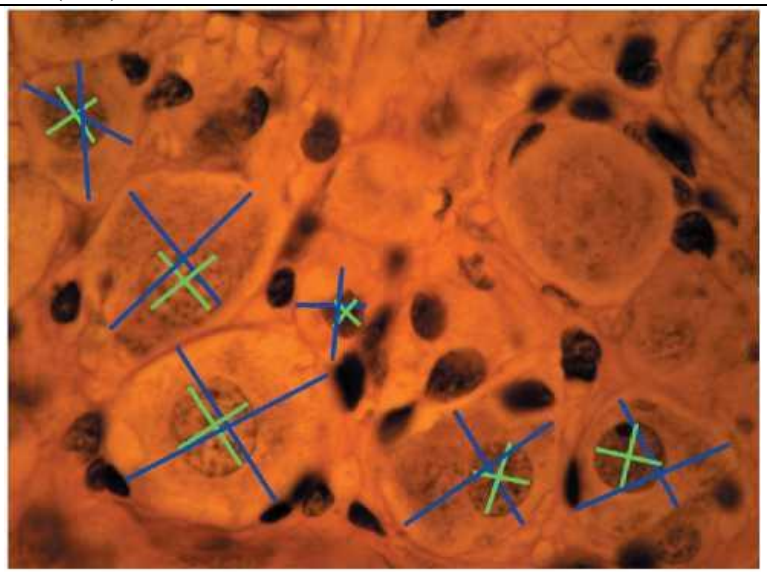


Рис. 1. Методика подсчета размера опухолевых клеток и их ядер. Синие отрезки используются для оценки размеров клеток, зеленые — ядер. х600.

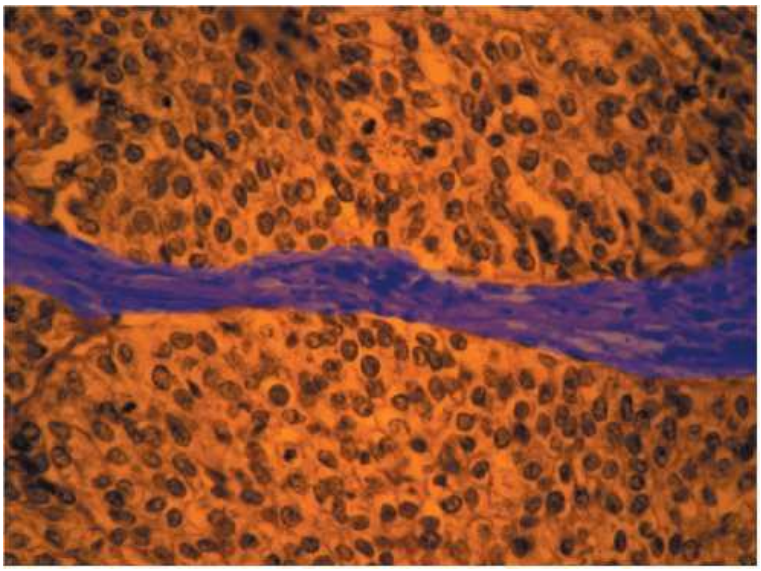


Рис. 2. Микрофотография опухоли, используемая для подсчета отношения площади стромы к паренхиме. Синим подкрашена строма опухоли. х100.

Результаты

После проведенной лучевой химиотерапии в опухоли определяются многочисленные клетки с вакуолизацией (рис. 3). Ядра часто удлинненые, гиперхромные, но чаще встречаются клетки с гомогенно бледно окрашеным ядром с хорошо видимыми гранулами хроматина преимущественно конденсированным вдоль ядерной оболочки. Редко встречаются клетки, в которых несколько ядер или ядерные мембраны со складками. Определяются скопления клеток, у которых значительно увеличины размеры клеток и ядер. Большое количество клеток, демонстрирующих реакцию на химиолучевое лечение, указывает на высокую эффективность используемого метода лечения.

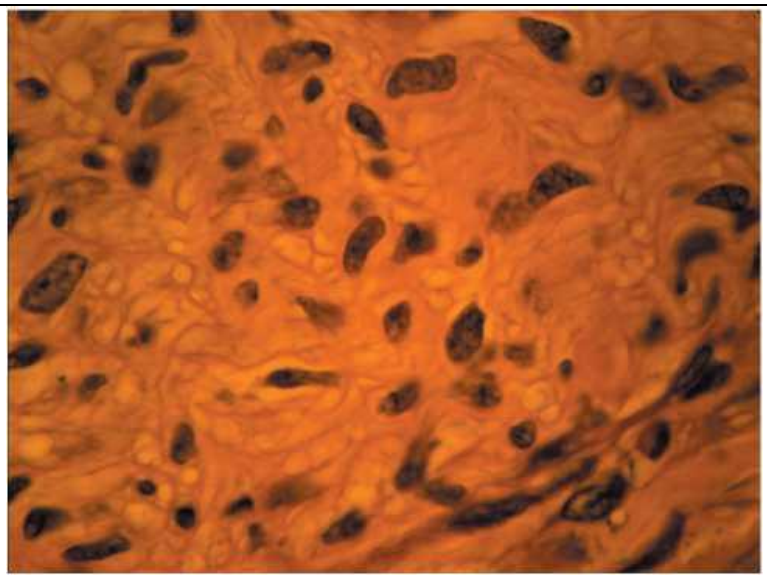


Рис. 3. Микрофотография рака шейки матки больной, прошедшей курс лучевой химиотерапии (контрольная группа). Большинство клеток вакуолизированы. Окраска гематоксилин-эозином. х600

При сравнении морфологической картины в опытной группе с контрольной, нами зафиксировано значительно меньшее количество клеток с признаками дегенерации под влиянием оксигенации, чем в контроле. Меньшее количество клеток с вакуолизацией цитоплазмы, с лизисом ядра, кариопикнозом и кариорексисом. Под влиянием оксигенации в опытной группе по сравнению с контрольной достоверно уменьшаются размеры клеток и их ядер (табл. 1).

Таблица 1

Размеры клеток и ядер опухолевых клеток в контрольной и опытной группах

Группа	Средний размер клетки (мкм)	Диаметр ядра (мкм)
Контрольная (ХЛТ без оксигенации)	58,3 ± 5,8	38,0±2,9
Опытная (ХЛТ с оксигенации)	47,5±6,2*	21,2±2,3*

Важно отметить, что у 3 больных в контрольной группе и у 4 в опытной результаты значительно отличались от средних значений в группе. Эти срезы были исключены из статистической обработки и дальнейшего изучения. Вероятно, в дальнейшем потребуется детальное исследование этого материала с целью определения факторов прогноза успешности каждого вида лечения плоскоклеточного рака шейки матки.

Под влиянием химиолучевой терапии происходит гибель опухолевых клеток, которые замещаются соединительной тканью, и в целом опухоль приобретает скиррозный характер. Вокруг групп опухолевых клеток определяет лимфоцитарная инфильтрация.

В опытной группе на фоне оксигенации по сравнению с контролем происходит увеличение стромы и соответственно уменьшение паренхимы (табл. 2). При этом соединительная ткань выглядит более зрелой и с меньшей лимфоцитарной инфильтрацией (рис. 4).

Таблица 2

Влияние оксигенации на изменение площадей стромы и паренхимы рака шейки матки (в %)

Группа	Строма	Паренхима
Контроль	62,7±6,3	37,3±2,6
Опыт	81,2±9,1*	18,8±2,3*

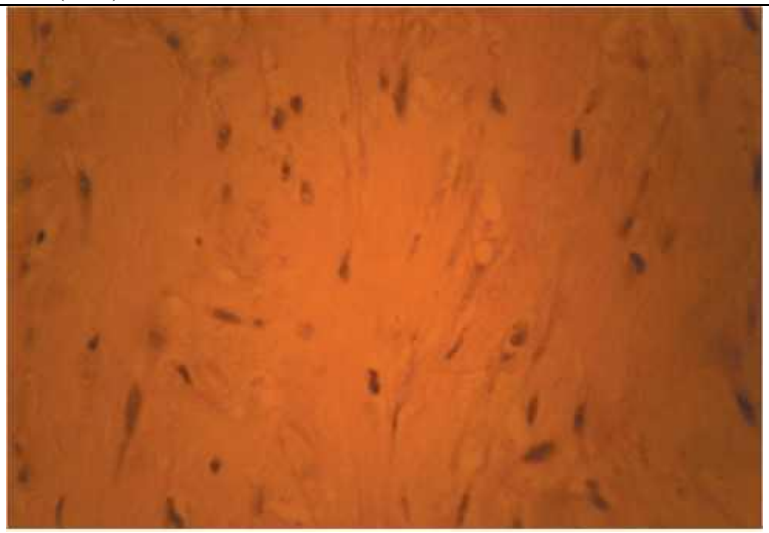


Рис. 4. Микрофотография рака шейки матки больной, прошедшей курс лучевой химиотерапии на фоне оксигенации (опытная группа). Окраска гематоксилин-эозином. х400

Наличие более выраженной лимфоцитарной инфильтрации в препаратах контрольной группы (химиолучевая терапия без оксигенации) является хорошим прогностичеким признаком, т.к. косвенно свидетельствует о стимуляции иммунитета. Однако повреждение паренхимы является одним из основных критериев оценки чувствительности опухоли к терапевтическому воздействию. Поэтому на основании морфометрических результатов и морфологической картины мы предполагаем, что под влиянием оксигенации не только погибло большее количество раковых клеток, но это произошло и на более ранних сроках, что проявляется в более зрелой соединительной ткани и меньшей инфильтрации лимфоцитами.

В работе впервые проведена морфометрическая оценка эффективности повреждающего действия химиолучевой терапии на плоскоклеточный рак шейки матки при оксигенации ткани опухоли и показано, что оксигенация опухоли повышает эффективность химиолучевой терапии.

Литература

1. Рак шейки матки / С. В. Хохлова, О. А. Кравец, К. Ю. Морхов [и др.] // Злокачественные опухоли. – 2023. – Т. 13, № 3S2-1. – С. 246-262.

2. Гадышева, М. А. Рак шейки матки как ВПЧ-ассоциированное заболевание: скрининг, профилактика и принципы лечения / М. А. Гадышева // Научное образование. – 2024. – № 2(23). – С. 31-33.

3. Рак шейки матки стадий IB2-IIIB: неоадъювантная химиотерапия, радикальные операции и выживаемость пациенток / Д. Л. Оводенко, Г. Н. Хабас, Ю. М. Крейнина [и др.] // Сибирский онкологический журнал. – 2021. – Т. 20, № 3. – С. 82-89.

4. Титова, В. А. Рак шейки матки: реалистичный подход к эволюционному развитию лучевой терапии, интеллектуальные и технические возможности. Взгляд эксперта / В. А. Титова // Вестник Российского научного центра рентгенорадиологии. – 2022. – Т. 22, № 4. – С. 361-372.

5. Дубинина, А. В. Современные методики химиолучевой терапии в лечении местнораспространенного ракашейки матки / А. В. Дубинина // Онкогинекология. – 2021. – № 1(37). – С. 75-87.

6. Кравец, О. А. Клинические результаты лечения рака шейки матки с учётом различных технологий в лучевой терапии / О. А. Кравец, А. А. Курманова, В. Н. Богатырев // Российский онкологический журнал. – 2022. – Т. 27, № 5. – С. 229-242.

7. Rao Q, Han X, Wei Y, Zhou H, Gong Y, Guan M, Feng X, Lu H, Chen Q. Novel prognostic nomograms in cervical cancer based on analysis of 1075 patients. Cancer Med. 2023 Mar;12(5):6092-6104.

8. Leath CA 3rd, Deng W, Mell LK, Richardson DL, Walker JL, Holman LL, Lea JS, Amarnath SR, Santos-Reyes LJ, Arend RC, Mayadev J, Jegadeesh N, DiSilvestro P, Chon HS, Ghamande SA, Gao L, Albuquerque K, Chino JP, Donnelly E, Feddock JM, Lowenstein J, Quick AM, Kunos CM, MacKay H, Aghajanian C, Monk BJ. Incorporation of triapine (T) to cisplatin chemoradiation (CRT) for locally advanced cervical and vaginal cancer: Results from NRG-GY006, a phase III randomized trial. Gynecol Oncol. 2025 Apr;195:122-133.

9. Mileshkin LR, Moore KN, Barnes EH, Gebski V, Narayan K, King MT, Bradshaw N, Lee YC, Diamante K, Fyles AW, Small W Jr, Gaffney DK, Khaw P, Brooks S, Thompson JS, Huh WK, Mathews CA, Buck M, Suder A, Lad TE, Barani IJ, Holschneider CH, Van Dyk S, Quinn M, Rischin D, Monk BJ, Stockler MR. Adjuvant chemotherapy following chemoradiotherapy as primary treatment for locally advanced cervical cancer versus chemoradiotherapy alone (OUTBACK): an international, open-label, randomised, phase 3 trial. Lancet Oncol. 2023 May;24(5):468-482.

10. Rai B, Dey T, Ballari N, Singh M, Miryala R, Srinivasa GY, Kataria V, Naseem R, Thakur S, Arun Singh O, Ghoshal S. Three-Dimensional Conformal Radiotherapy Versus Image-Guided Intensity Modulated External Beam Radiotherapy in Locally Ad-

vanced Cervical Cancer: A Phase III Randomized Control Study. Clin Oncol (R Coll Radiol). 2024 Nov;36(11):728-737.

11. Fachini AMD, Zuliani AC, Sarian LO, Teixeira JC, Esteves SCB, da Costa Machado H, Zeferino LC. Long-term outcomes of concomitant cisplatin plus radiotherapy versus radiotherapy alone in patients with stage IIIB squamous cervical cancer: A randomized controlled trial. Gynecol Oncol. 2021 Feb;160(2):379-383.

PEDAGOGICAL SCIENCES

BAKHTIYAR VAHABZADE'S INTEGRATION OF PATRIOTISM AND NATIONALITY IDEAS INTO THE TEACHING OF MATHEMATICS

Abdullayeva M.
Doctor of Philosophy in Pedagogy, Associate Professor
Azerbaijan State Pedagogical University, Faculty of Mathematics
Department of Mathematics and its teaching technology, Baku
DOI: 10.5281/zenodo.18084462

ABSTRACT

One of the essential objectives of mathematics education in general secondary schools is to develop students' mathematical knowledge alongside moral values such as patriotism and national identity. In this regard, the integration of literary elements into mathematics teaching offers valuable pedagogical opportunities. This study examines the possibilities of integrating the patriotic and national ideas expressed in the poetry of the prominent Azerbaijani poet Bakhtiyar Vahabzadeh into mathematics instruction.

The purpose of the research is to explore the pedagogical potential of Vahabzadeh's poetry within the teaching of the topic "The equation of a straight line passing through two points" in the 8th grade. The study employs text analysis to identify suitable poetic excerpts and classroom observation to evaluate their instructional impact. During the lesson, selected poetic lines were used at the motivation stage, while mathematical tasks were designed using the coordinates of culturally and historically significant Azerbaijani cities such as Shusha, Khankendi, Khojaly, and Baku.

The findings indicate that this integrative approach enhances students' interest in mathematics, supports a deeper understanding of mathematical concepts, and contributes positively to the development of patriotic awareness. The study concludes that the integration of national values into mathematics teaching represents an effective and purposeful educational approach.

Keywords: mathematics education, Bakhtiyar Vahabzadeh, patriotism, integration, equation of a straight line.

Introduction

In the contemporary education system, one of the primary priorities is not only the acquisition of subject-specific knowledge but also the formation of national and moral values, patriotism, and civic responsibility among students. In the context of the challenges of the twenty-first century, education in Azerbaijani schools should not be limited solely to the transmission of knowledge; rather, it should also be oriented toward the holistic development and moral formation of the learner. From this perspective, fostering national consciousness, love for the homeland, and civic awareness through both natural sciences and humanities represents an aktуal pedagogical task.

Within Azerbaijani literature, the prominent poet and public figure Bakhtiyar Vahabzadeh occupies a special place as a representative of national ideas, patriotism, and moral integrity. His works, such as *"Mother Tongue," "Gulustan," "To the Homeland,"* and *"Azerbaijan,"* reflect themes of national identity, freedom, historical memory, and devotion to the homeland, and thus possess significant pedagogical potential for the moral education of younger generations. These literary works can serve as effective didactic resources for developing students' national self-awareness and civic positions.

In pedagogical and academic literature, Bakhtiyar Vahabzadeh's creative legacy has been examined mainly from literary, philosophical, and ideological perspectives, while his pedagogical views have also attracted scholarly attention. For instance, a publication on the Kaspi.az portal in 2022 emphasized the poet's views on the principle of visuality in teaching and the importance he attributed to educating youth in a national spirit (Kaspi.az, 2022).

However, studies focusing on the integration of Vahabzadeh's poetry into the teaching of non-humanitarian subjects, particularly mathematics, remain limited. One of the first academic attempts in this direction is the author's 2023 article entitled *"The Use of Bakhtiyar Vahabzadeh's Poetry in Developing Patriotic Feelings among Students in Mathematics Lessons."* This study substantiated that mathematics education is not restricted to the development of logical and analytical thinking, but can also function as an effective means of fostering national and moral values. Presenting mathematical tasks in real-life and nationally contextualized situations contributes to strengthening students' patriotic feelings, national pride, and respect for cultural heritage.

Additionally, the materials of an academic-practical conference held in Shaki in 2015 addressed the educational influence of Bakhtiyar Vahabzadeh's creative works (shrem.az, 2015); however, the integration of poetry into mathematics education was not examined. This gap highlights the relevance and novelty of integrative research connecting Vahabzadeh's literary heritage with non-humanitarian disciplines, particularly mathematics.

Therefore, this article analyzes the possibilities of applying Bakhtiyar Vahabzadeh's poetry in conjunction with mathematics teaching and explores how his patriotic and national ideas can be implemented within a mathematical learning environment from a pedagogical perspective. The theoretical and practical ap-

proaches proposed in the study aim to expand the potential of interdisciplinary integration and to offer a new perspective on the role of mathematics education in strengthening national identity.

A scientific and pedagogical interpretation of patriotic and national identity ideas in Bakhtiyar Vahabzadeh's creative works

Bakhtiyar Vahabzadeh is one of the leading literary figures in twentieth-century Azerbaijani poetry who consistently and systematically articulated the ideas of patriotism and national identity. In his creative works, concepts such as homeland, mother tongue, historical memory, and national belonging transcend purely poetic and aesthetic boundaries and acquire social and pedagogical significance. Poems such as *"Homeland," "Mother Tongue,"* and *"Gulustan"* are regarded as conceptually significant examples in Azerbaijani literature in terms of preserving national and moral values, shaping historical consciousness, and strengthening national identity.

In the poem *"Homeland,"* the concept of the homeland is presented not as a geographical category, but as a unity of historical memory, cultural heritage, and moral responsibility. The poet emphasizes not physical borders, but rather language, culture, and the spiritual unity of the people. This approach contributes to the formation of the homeland as a value-oriented concept in the consciousness of younger generations (Vahabzadeh, 1983).

In the poem *"Mother Tongue,"* language is portrayed as the fundamental carrier of national existence. The poet stresses that the mother tongue is not merely a means of communication, but is organically connected with a nation's historical memory, worldview, and cultural identity.

Indifference toward language is interpreted not as an individual issue, but as a socio-cultural factor posing a threat to society as a whole. This position presents the protection of the mother tongue as an essential condition for the continuity of national identity (Vahabzadeh, 2003).

In the poem *"Gulustan,"* the historical destiny of the Azerbaijani people, particularly the political division that occurred at the beginning of the nineteenth century, is reflected through poetic generalization. The poem addresses the division of Azerbaijan as a result of the Gulistan Treaty of 1813 and the Turkmenchay Treaty of 1828, which forced people sharing the same ethnic and cultural identity to live within different political entities. This work is considered an important ideological and artistic source for shaping attitudes toward historical injustice, strengthening national consciousness, and developing the idea of Azerbaijani identity.

When presented purposefully and methodologically in general education schools, Bakhtiyar Vahabzadeh's creative legacy has a significant impact on the formation of students' national identity awareness, patriotic values, and civic positions. These works enable students not only to comprehend national and cultural heritage but also to develop analytical approaches to historical facts, value-based thinking, and a sense of social responsibility. In this respect, Bakhtiyar Vahabzadeh's poetry possesses strong ideological and pedagogical potential that can be applied within the framework of interdisciplinary integration in the educational process, including the teaching of mathematics.

Pedagogical opportunities for fostering national spirit in mathematics education

In the modern education system, one of the key objectives is not only the acquisition of subject-specific knowledge by students, but also their development based on national and moral values. In this context, mathematics education should not be limited to the development of logical and analytical thinking; it should also contribute to the formation of such qualities as patriotism, national belonging, and civic responsibility. When appropriately designed in terms of content and methodology, mathematics instruction provides effective pedagogical opportunities for integrating national spirit into the learning process.

Linking the content of mathematical tasks to real-life situations and national contexts has a positive impact on both the consolidation of mathematical knowledge and the development of national identity awareness among students. For example, contextualizing problems involving rational numbers with references to Azerbaijan's geographical regions, historical figures, and cultural heritage enhances students' cognitive engagement while strengthening the educational and moral potential of mathematics instruction. Such an integrative approach reduces the abstract nature of mathematics and makes it more meaningful and socially relevant for learners.

Moreover, the purposeful use of literary and artistic materials in the teaching process enhances the emotional and psychological impact of the lesson and fosters students' interest in national and moral values. In this regard, the patriotic and national identity themes reflected in the poetry of Bakhtiyar Vahabzadeh can serve as motivational and educational tools in mathematics lessons. For instance, the following lines from the poem *"Homeland"* (Vahabzadeh, 2008) may be used at the introductory stage of the lesson to create a problem situation and stimulate students' emotional and intellectual engagement.

The deliberate integration of such literary excerpts into the structure of mathematics lessons facilitates not only the acquisition of mathematical concepts but also the internalization of national ideals and civic values. The primary objective of this approach is not merely to evoke emotional responses but to provide pedagogical support for the holistic development of students' personalities, including the formation of national identity awareness and a sense of social responsibility.

For example, when teaching the topic *"The Equation of a Straight Line Passing Through Two Points"* in the eighth grade, the teacher should consider not only the development of students' mathematical knowledge and skills in lesson planning, but also the educational and moral potential of the topic. During instruction, the ideas of national spirit, love for the homeland, and freedom reflected in the creative works of Bakhtiyar Vahabzadeh can be integrated into the teaching process in a contextual and purposeful manner.

At the motivation and problem-setting stage of the lesson, the teacher may recite a line from Vahabzadeh's

patriotic poetry in order to enhance students' emotional and cognitive engagement. For instance, the line: *"A land is homeland if there are those who die for it!"* not only arouses students' interest in the lesson, but also defines its ideological and conceptual direction. At this stage, the teacher may address the class with the following guiding question: *"If we attempted to express the concept of the homeland in mathematical terms, what form might it take?"* This question encourages students to establish connections between abstract mathematical concepts and real-life national contexts.

Following the motivation stage, the teacher specifies the problem and presents the following task: *Write the equation of the straight line passing through the points* $Shusha\,(3;5)$ *and* $Khojaly\,(7;9)$. Through this task, students learn how to construct the equation of a straight line passing through two given points while simultaneously interpreting mathematical activity within a national and moral context. In this way, the mathematical concept is moved beyond an abstract level and gains meaningful, value-oriented content for students.

At this stage, the teacher introduces the new topic: *"Today's lesson is devoted to the equation of a straight line passing through two points."* Subsequently, the theoretical foundations of the topic are presented, and the equation of a straight line passing through two points is expressed by the following formula:

$$\frac{y-y_1}{x-x_1}=\frac{y_2-y_1}{x_2-x_1}$$

By using the given formula, students apply their mathematical knowledge to practical tasks while simultaneously developing a conscious understanding of concepts such as attachment to the homeland and national memory through examples presented in a national context.

Such an integrative approach contributes not only to the formation of students' mathematical skills but also to the development of their attitudes toward national and moral values, their civic positions, and their sense of social responsibility. In mathematics lessons, tasks constructed using the coordinates of historically and culturally significant locations in Azerbaijan, together with selected excerpts from the poetry of Bakhtiyar Vahabzadeh, serve as important tools for enhancing both the didactic and educational effectiveness of the learning process.

Example 1: Write the equation of the straight line passing through the points $Shusha\,(3;5)$ and $Khojaly\,(7;9)$ and construct its graph.

Solution: $x_1=3,\ y_1=5$ və $x_2=7,\ y_2=9$

$$\frac{y-5}{x-3}=\frac{9-5}{7-3}\ \Rightarrow\ y-5=\frac{4}{4}(x-3)\ \Rightarrow\ y-5=x-3\ \Rightarrow\ y=x+2$$

The equation of the straight line passing through the points $Shusha\,(3;5)$ and $Khojaly\,(7;9)$ is expressed in the form $y=x+2$. The graph of the given straight line was constructed using the Graph 4.4 program (Figure 1). In the process of constructing the graph, students practically master the mechanism of application of the equation of the straight line passing through two points, and at the same time develop mathematical modeling skills.

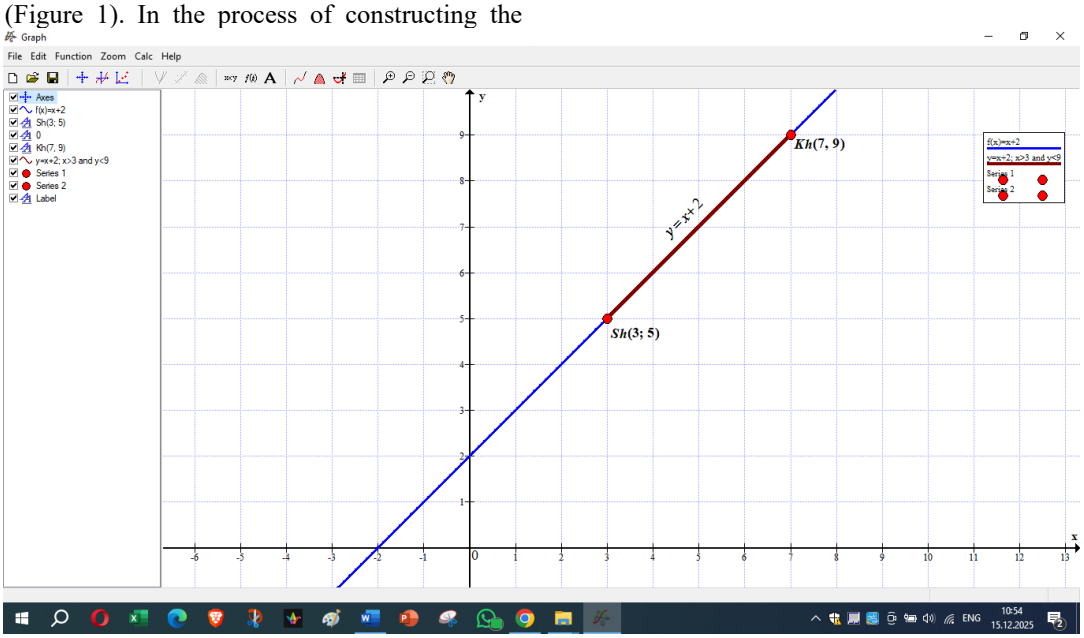


Figure 1. Graph of the straight line passing through the points Sh(3, 5) and Kh(7, 9)

Although the equation of a straight line passing through two points mathematically represents the functional relationship connecting given coordinates, presenting this topic within a national and historical context enhances its educational value by selecting the points Shusha and Khojaly as places bearing profound national and moral significance. From this perspective, the constructed straight line symbolically expresses not only the relationship between mathematical objects but also the spiritual connection between geographical and

historical locations that occupy a special place in the national memory of the Azerbaijani people.

While completing the task, students do not merely apply their mathematical knowledge; they also gain information about Azerbaijan's historical and geographical sites. Thus, the presented mathematical model becomes a didactic tool that creates an integrative link between geographical space and historical as well as national–moral memory. This approach enables abstract mathematical concepts to be understood within a social and cultural context in mathematics lessons.

In order to strengthen the educational and moral impact of the lesson, the following lines, written by Bakhtiyar Vahabzadeh in a patriotic spirit, may be recited at an appropriate stage of the lesson:

O son of the Motherland, think and know that this land is yours;

It's tomorrow, it's today, and it's yesterday, all belong to you.

You have your own state, your own nation, your own ancestors;

Those who die for the Motherland are reborn beyond death (Vahabzadeh, 1992).

The purposeful integration of this literary example into the teaching process provides pedagogical support for the formation of values such as patriotism, national identity, and civic responsibility among students, and significantly enhances the educational potential of mathematics lessons.

Example 2: Write the equation of the straight line passing through the points $Khankendi\,(2;4)$ and $Baku\,(6;10)$, and draw its graph.

Solution: $x_1=3,\ y_1=5$ və $x_2=7,\ y_2=9$

$$\frac{y-5}{x-3}=\frac{9-5}{7-3} \Rightarrow y-5=\frac{4}{4}(x-3) \Rightarrow y-5=x-3 \Rightarrow y=x+2$$

The equation of the straight line passing through the points $Khankendi\,(2;4)$ and $Baku\,(6;10)$ is expressed in the form $y=x+2$. Figure 2 depicts the graph of the straight line passing through the points (2; 4) and (6; 10). In the graph, both points are marked on the coordinate plane, and a straight line connecting these points is constructed. This process develops the ability of students to interpret the graph of a linear function.

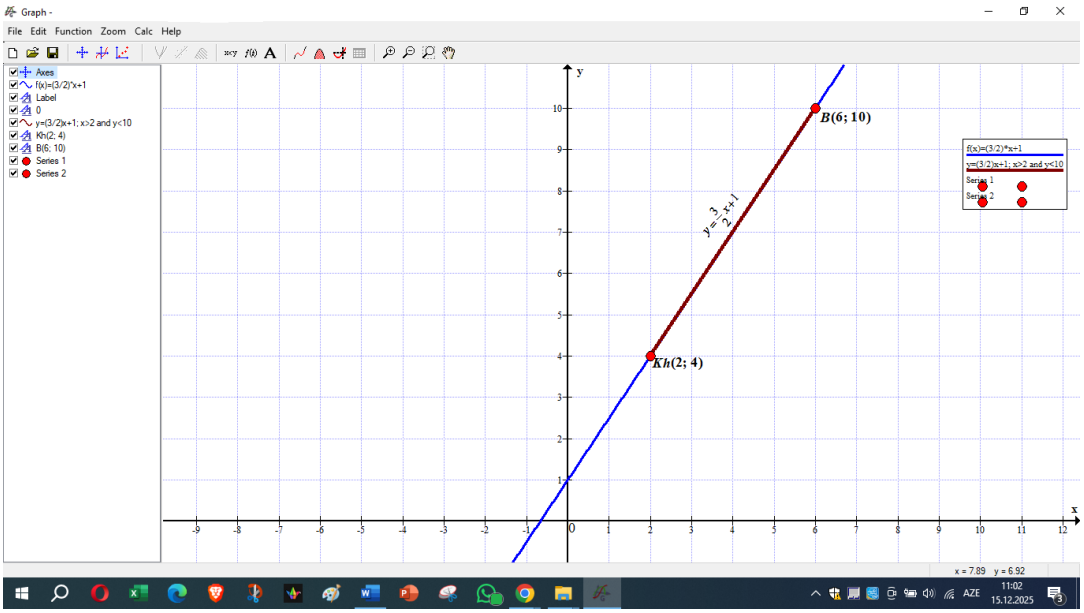


Figure 2. Graph of the straight line passing through the points Kh(2, 4) and B(6, 10)

Mathematically, the equation of the given straight line represents the linear relationship between two points; however, the task's content is not limited solely to mathematical activity. The fact that the specified points correspond to significant geographical locations in Azerbaijan allows students to perceive mathematical activity within a national and moral context. This approach contributes to the development of students' understanding of geographical spaces and reinforces their knowledge of cities with historical and social significance.

To enhance the educational and moral impact of the task, the following lines reflecting Bəxtiyar Vahabzadə's patriotic ideas can be purposefully incorporated into the teaching process:

Ours is Azerbaijan, the homeland of the Turkic Oghuz,

Brave sons and daughters, the homeland belongs to you.

Freedom is your right, faith is your passion,

Justice and humanity stem from what is right.

Our nation shares humanity's suffering as its own,

Our liberty grows from our intentions. (Vahabzadə, 1992)

Integrating this literary example into the mathematics lesson pedagogically supports the formation of students' values, such as national identity, patriotism, and civic responsibility, significantly enhancing the moral potential of the lesson.

Thus, through these integrative tasks, students not only develop the ability to write the equation of a straight line passing through two points and graph it, but also gain an understanding of the historical and cultural significance of cities like Shusha and Khojaly, Khankendi, and Baku in Azerbaijan's history and national consciousness. This approach ensures the integration of cognitive and moral objectives, exemplifying the effective application of interdisciplinary and values-based integration in mathematics lessons. In this context, the mathematics lesson serves both to achieve content standards and to foster students' social and moral competencies, including patriotism and national identity, within a purposeful learning environment.

Conclusion

The integration of patriotism and national identity themes from Bəxtiyar Vahabzadə's poetry into mathematics lessons has a significant positive impact on students' engagement, as well as their emotional and moral comprehension of the subject matter. Such an integrative approach not only facilitates a deeper and more conscious understanding of mathematical concepts but also fosters the development of students' sense of patriotism and national belonging.

Establishing purposeful and meaningful connections between mathematics and literature promotes students' critical and creative thinking skills, demonstrating the effective application of interdisciplinary integration within the teaching process.

As a result of this approach, students acquire not only mathematical knowledge and skills but also develop as individuals who understand and value national and moral principles, while forming a responsible civic stance. Thus, the educational process transcends mere knowledge transmission and becomes a deliberate pedagogical practice aimed at holistic personality development.

Consequently, Bəxtiyar Vahabzadə's ideas of patriotism and national identity serve not only as a resource for literature lessons but can also be strategically employed across various educational domains. Purposeful use of this literary heritage in mathematics lessons contributes to students' intellectual and moral growth, positioning the integration of B. Vahabzadə's poetry with mathematics as a pedagogically significant tool for nurturing socially responsible, intellectually mature, and nationally conscious citizens.

References

1. Abdullayeva, M. (2023). Using Bəxtiyar Vahabzadə's poetry to instill patriotism in students during mathematics lessons. In *Proceedings of the 5th International Bəxtiyar Vahabzadə Congress on History, Culture, and Literature of the Turkic World* (Şəki, Azerbaijan). https://www.scienceazerbaijan.org

2. Ministry of Education of the Republic of Azerbaijan. (2013). *Mathematics curriculum for general education institutions (Grades I–XI)*. Baku, Azerbaijan.

3. Vahabzadə, B. (2004). *Selected works* (Vol. I, Poems). Baku, Azerbaijan: Öndər Publishing. 328 pp.

4. Vahabzadə, B. (2004). *Selected works* (Vol. II, Poems). Baku, Azerbaijan: Öndər Publishing. 320 pp.

5. Vahabzadə, B. (2008). *Works* (Vol. VI, 1990–1999). Baku, Azerbaijan: Elm. 738 pp.

6. Vahabzadeh B. (1992). National Anthem. https://melumatlar.az/blog/16095/veten-marsi-bextiyar-vahabzade

7. International Bəxtiyar Vahabzadə Congress on History, Culture, and Literature of the Turkic World. (2023, August 16–17). Şəki, Azerbaijan. *Conference proceedings*. Ankara, Turkey: İKSAD Publishing House. https://iksadkongre.org/

8. Bəşirov, K. (2015). *Monograph dedicated to the pedagogical views of Bəxtiyar Vahabzadə*. https://www.kaspi.az/az/bextiyar-vahabzadenin-pedaqoji-gruslerine-hesr-olunmus-monoqrafiya

9. IKSAD and Baku Eurasian University. (2024, 15–17 August). Proceedings of the VI International Bakhtiyar Vahabzade: Turkic World History, Culture and Literature Conference. Lerik, Azerbaijan. https://baau.edu.az

APPLYING RECIPROCAL TEACHING APPROACHES FOR DEVELOPING STUDENTS' READING COMPREHENSION SKILLS

Gantsetseg Sanjmyatav
(Ph.D) Associate professor, Mandakh University, Mongolia
Oyun-Erdene Erdenebileg
Senior Lecturer, Mandakh University, Mongolia
DOI: 10.5281/zenodo.18084476

ABSTRACT

Reading is undoubtedly a core skill for students learning a second language. Although reading tasks are more commonly used than other language skills in English classrooms, students' receptive skill outcomes remain low. The reason is associated with the lack of effective reading strategies to enhance comprehensive understanding in reading classes. This study aimed to investigate the effect of Reciprocal Teaching Method (RTM) on the development of EFL learners' reading comprehension skills. RTM incorporates four key strategies: predicting, clarifying, question generating, and summarizing. Beyond supporting students in understanding reading texts, the method also offers opportunities for learners to monitor their own learning and thinking processes. Furthermore, RTM fosters the development of metacognitive skills, leading to improved critical thinking abilities. The participants of the study were 36 university students majoring in Finance and Banking. The findings revealed that RTM leads to better performance, deeper understanding, and stronger long-term learning compared to traditional teaching methods. Specifically, the control group shows a modest gain of about 4.6 percentage points from pre-test to post-test. But the experimental group shows a much larger gain - almost 9 percentage gaps. This demonstrates that the Reciprocal Teaching Method was noticeably more effective in improving students' reading comprehension skills.

Keywords: reciprocal teaching, EFL learners, improving reading comprehension, metacognitive skills, reading strategies, experimental training.

INTRODUCTION

Reading is perceived in various ways as considered as a receptive skill for students' growth in many aspects of their individual life. It is deemed the most crucial activity, serving not only as a source of information and enjoyable experience, but also as a beneficial method for enhancing learners' understanding of language and extending their knowledge, literature and culture to contribute in every aspect of life (Prastyo, 2017). Qurrotul A'yun (Yunus, 2017) claimed that reading is the message receiving activity to understand the content of a text and construct meaning which involves the interaction between text and the reader. According to Mohammad Reza Ahmadi and Abbas Pourhossein Gilakjani (Gilakjani, 2012), reading is a cognitive process that consists of a reader, a text, and the interaction between the reader and the text. Based on the above definitions, reading comprehension can be defined as the mental process of interaction between writer and the reader. In other words, it is explained that the writer encodes a message while the reader decodes the meaning from the text (Rojabi, Exploring reciprocal teaching method on EFL learners' reading comprehension, 2021). As reading comprehension is a mental and constructive process, it involves mental operations through both cognitive and metacognitive strategies that learners can use when they read. Cognitive strategies are used for summarizing, giving reasons, predicting, taking notes on the main points, using prior knowledge, and guessing meaning from the context. Metacognitive strategies allow readers to control their planning, evaluating, and regulating skills by determining the reading task, evaluating the predictions, focusing on important information, checking the effectiveness of guessing meaning, re-reading relevant information, and checking the effectiveness of achieving the whole reading task (Gilakjani, 2012).

Unfortunately, some students confronted with reading difficulties to gain the text's comprehensive meaning. Under the observation in the reading class, some students engaged passive and unmotivated with limited understanding. One of the reasons for this situation is that the conventional reading method, commonly known as the grammar-translation method, is typically applied in the Mongolian context. Students read particular English passages, translate them into Mongolian language and answering some comprehensive questions. The conventional methods have less effects on students' reading comprehension and motivation to read. That's why, the problem arises from the lack of effective strategies for applying logical and systematic reading techniques that can enhance comprehensive understanding in reading classes. The unproper instruction for reading activities are affected to create an inappropriate interaction and less enjoyable atmosphere between teacher and students. Due to the above concern, it is hoped that a specific reading strategies like reciprocal teaching method (RTM), as it is a cooperative learning practice, can be a solution to overcome the learners' challenges in reading comprehension at tertiary level. Reciprocal teaching is originally developed by Palincsar and Brown to improve students' reading comprehension. The method is step by step procedure and emphasize in the following four strategies: predicting, clarifying, questioning and summarizing to enhance reading comprehension (Oczkus, 2018). Theoretically, this method is considered suitable for developing reading comprehension, as it involves several steps through which students activate their prior knowledge, relate it to the reading topic, and enhance understanding through clarification and summarization.

Research questions: The following questions were elaborated below under the research topic.

1. Is there any significant effect of reciprocal teaching method on improving the students' reading comprehension?

2. Is there any significant effect of meta-cognition strategy for applying reciprocal teaching method in the comprehensive reading class?

Research purpose and objectives: This study aimed to investigate the effect of Reciprocal Teaching Method (RTM) on the development of EFL learners' reading comprehension skills at Mandakh University, Mongolia. The study attempted to achieve the following objectives:

1. To compare the effectiveness of the reciprocal teaching approach on students' reading comprehension between experimental and control groups
2. To investigate effectiveness of meta-cognition strategy for applying reciprocal teaching approach between experimental and control groups of comprehensive reading class

LITERATURE REVIEW

Many academics have investigated the efficiency of reciprocal teaching in the university setting (Wimonphon Rawengwan, 2020). The Reciprocal Teaching Model (RTM) enhances reading comprehension through four strategies: predicting, clarifying, questioning, and summarizing. Predicting links prior knowledge to new information, while clarifying helps resolve confusion and monitor understanding. Questioning guides readers to identify main ideas and key details, and summarizing condenses information and connects ideas across paragraphs. Together, these strategies encourage active engagement with the text and improve overall comprehension (Alsaraireh, 2016).

In the EFL setting, a researcher I-Chia Chou explored the use of reciprocal teaching with Taiwanese university students enrolled in English Medium Instruction (EMI) courses (Chou, 2016). The results revealed a substantial difference between the test scores before and after the reciprocal teaching intervention. The researcher proposed that the reciprocal teaching style might help Taiwanese students learn academic texts and prepare the EFL teacher for future studies in other EMI courses (Chou, 2016). Similarly, Alsaraireh and Hamid evaluated the influence of applying reciprocal teaching method, or RTM, on first-year university students in Jordan through RTM successes in reading competence, concentrating on students' gender (Ku Mohd Nabil Ku Hamid, 2016).

Studies across different contexts found that students using RTM achieved higher scores, developed better strategies, and showed more positive attitudes toward learning (Peter E.Doolittle, 2006). A systematic review made by Ting Pick Dew and others aimed to identify, evaluate and synthesize the evidence regarding the use of reciprocal teaching as a reading intervention for English as a Second Language (ESL) learners. Additionally, it investigated the specific features that contribute to the effectiveness of reciprocal teaching in ESL reading comprehension classrooms (Ting Pick Dew, 2021). As cited by Ting Pick Dew, a significant meta-analytical research conducted by Rosenshine and Meister (1994) supported Palincsar and Brown's (1984) concept of reciprocal teaching as a form of explicit instruction that promotes metacognition throughout the meaning-making process. This claim was later reinforced by McAllum (2014), who described reciprocal teaching as a blend of reading strategies that includes the explicit instruction of metacognitive strategies and a dialogical process that fosters understanding and comprehension, aligning with the shift in reading paradigms (Carter, 1997) (Ting Pick Dew, 2021).

In essence, reciprocal teaching treats reading as a joint endeavor, where the comprehension process involves collaborative instructional strategies that allow small groups of students to learn and apply four reading strategies through guided support. According to the literature reviews, most researches have shown that EFL students often perform poorly in reading comprehension. This is mainly due to three factors, firstly, limited knowledge of reading strategies, secondly, ineffective teaching practices that focus only on silent reading and answering questions without enough time or skill-building, and thirdly, some learners' reluctance or lack of motivation to engage in higher-level reading tasks. Research consistently shows that the RTM enhances reading comprehension more effectively than traditional or translation methods.

RESEARCH METHODOLOGY

Research design: The study was employed experimental design with the examination of the effect on reciprocal teaching method as independent variable, and students' reading comprehension as dependent variable. The researcher were as active agents rather than a passive observer.

Quasi-experimental design was applied with pre-test and post-test to achieve the research purpose. The pre-test aim was to check the level of reading comprehension of two groups. The post-test aim was to compare the score of the two groups to evaluate which group gain better score and whether the score is significantly different or not.

Hypothesis 1: RTM affects students to improve their reading comprehension.

Hypothesis 2: Meta-cognition strategy affects students to acquire RTM to monitor their reading comprehension.

Population and sampling: The population consisted of 36 EFL students at Mandakh University, who are majored in Finance and Banking in the academic years 2024-2025 and 202-2026. The participants were assigned to experimental and control groups based on existing class condition rather than randomly. Thus, the experimental group (Group 1) with 20 students were taught by using the RTM. Meanwhile, the control group (Group 2) with 16 students were taught by using the conventional method. To fulfill the research validity requirements, both groups were taught in the same courses and during the same time period. The research administrators informed all participants about the purpose of the study, the data collection process conducted before starting the research implementation, and provided feedback after the experiment. However, the students were not informed about the group to which they had been assigned.

Research Instruments: This study included the following instruments according to the target objectives.

- Reading comprehension placement test: the Cambridge Placement Test (English, 2025) with 25

items was used to find the students' English proficiency level.

- Reading comprehension pre and post tests were taken to compare reading comprehension skills before and after experiment (Teens, 2025).
- Semi-structured interview was undertaken to provide the research reliability and validity.

FINDINGS

This study aimed to investigate the effectiveness of the Reciprocal Teaching Method (RTM) in enhancing students' reading comprehension skills. The participants were junior students from Mandakh university in the frame of Quasi-experimental design. According to the principal of the quasi-experimental design, the participants were assigned into two groups. The experimental group consisted of 20 EFL learners who were instructed using the reciprocal teaching method, while the control group, with 16 EFL learners, received instruction through traditional teaching methods. English proficiency level of the participants was between B1 and B2 level (CEFR), as intermediate that set through a Cambridge General English Placement test with 25 items (English, 2025) before starting the experiment.

Before starting the experiment two groups took pre-test to evaluate the reading comprehension of the participants with B1-level reading texts and post-test was administered after actions to know the learners' improvement on reading comprehension with a standardized test.

During reading, research data were gathered through classroom observation, RTM evaluation worksheets aligned with the four RTM strategies. The worksheets guided students through predicting, clarifying, questioning, and summarizing at each step of the reading process, ensuring consistency and structure. This tool helped us measure how effective the method was and how students experienced the strategies during reading.

A standardized reciprocal teaching rubric, accessible online, was employed for the evaluation.

Table 1

Reciprocal teaching rubric for informative reading

SKILLS		1 point	2 points	3 points
Pre-reading	Predicting	The student has great difficulty formulating a prediction.	The student makes predictions about the text but doesn't utilize text clues consistently.	The student utilizes text clues to make logical predictions before, during and after reading.
	Questioning	The student has great difficulty formulating a question for others and relies on teacher support.	The student asks a question that is based on an information of the text.	The student asks a question that requires making inferences about the text.
While-reading	Clarifying	The student is unable to identify anything they find confusing in / about the text.	The student can identify something confusing in/about the text but cannot use a clarifying strategy.	The student can identify something confusing in/about the text and can use a clarifying strategy.
Post-reading	Summarizing	The student has great difficulty summarizing the article	The student summaries most of the article accurately, but has some slight misunderstanding	The student uses only 1-3 sentences to describe clearly that the article is about

The performance of both the control group and the experimental group across the four key reading strategies used in Reciprocal Teaching was shown in the figure 1. The summary for each stage was described as bellowed.

Predicting	Control group					Experimental group					
	T1	T2	T3	T4	Average %	T1	T2	T3	T4	T5	Average
	1	1	3	3	66%	3	2	3	3	2	86.6%
Questioning	Control group					Experimental group					
	T1	T2	T3	T4	Average %	T1	T2	T3	T4	T5	Average
	2	3	2	3	83.3%	3	2	3	3	3	93.3 %
Clarifying	Control group					Experimental group					
	T1	T2	T3	T4	Average %	T1	T2	T3	T4	T5	Average
	2	3	3	1	75 %	3	3	2	3	1	80 %
Summarizing	Control group					Experimental group					
	T1	T2	T3	T4	Average %	T1	T2	T3	T4	T5	Average
	3	1	2	2	66.7%	3	3	2	3	2	86.7 %

Figure 1. Progress of the experiment

Predicting: The control group achieved an average of 66%, while the experimental group reached 86.6%. This is a large difference and shows that students in the experimental group became much more effective at making predictions about the text. RTM clearly helped them anticipate content and engage more actively with the reading material.

Questioning: Both groups performed fairly well, but the experimental group still outperformed the control group. The control group scored 83.3%, while the experimental group scored 93.3%. This suggests that Reciprocal Teaching significantly strengthened students' ability to generate meaningful questions and interact with the text at a deeper level.

Clarifying: The clarifying strategy shows the smallest gap between the two groups. The control group averaged 75%, while the experimental group averaged 80%. Although the difference is not as large as in other strategies, the experimental group still shows a noticeable advantage. This indicates that both groups struggled to some extent with clarifying unclear parts of the text, but RTM still provided an additional boost.

Summarizing: There was strong difference in the summarizing strategy. The control group achieved 66.7%, while the experimental group reached 86.7%. This is a substantial improvement, showing that RTM helped students summarize information more accurately and coherently, reflecting deeper comprehension.

Overall, across all four strategies, the experimental group consistently outperformed the control group. The largest improvements appear in predicting and summarizing, which are higher-order comprehension skills. These results demonstrate that the Reciprocal Teaching Method has a strong positive impact on students' reading strategy use and overall reading comprehension.

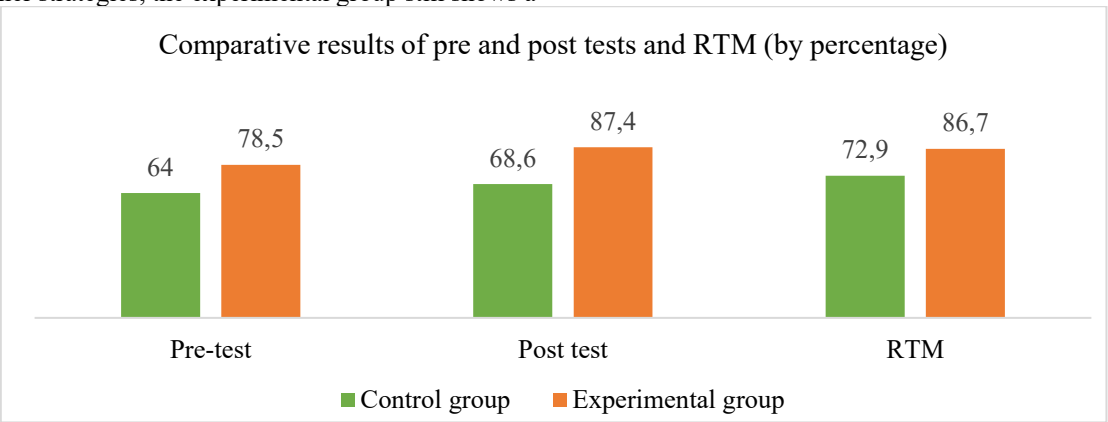


Figure 2. Comparative result of Pre-test and post -test scores and RTM

There was a comparison of the average score differences between the control group and the experimental group across three stages: the pre-test, the RTM average, and the post-test. In terms of the key points, first, pre-test score starts at 64% of the control group, which represents their baseline reading comprehension level before any instruction began. During the instructional period, their average score rises to 72.9%, showing some improvement through regular classroom teaching. However, in the post-test, their score slightly decreases to 68.6%. This tells us that although the students experienced short-term improvement during the

lessons, the traditional method did not support strong long-term retention or consistent progress.

In terms of the experimental group, which was taught using the Reciprocal Teaching Method, their initial pre-test score is already higher, at 78.5% than the control group, but what is important here is the amount of improvement they show. During the RTM sessions, their average score increases significantly to 86.7%. And in the post-test, they reach 87.4%, which indicates not only strong learning during the intervention but also excellent retention of their new skills. When we compare the two groups, the difference becomes very clear. The control group shows a modest gain of about 4.6 percentage points from pre-test to post-test. But the experimental group shows a much larger gain - almost 9 percentage gaps. This demonstrates that the Reciprocal Teaching Method was noticeably more effective in improving students' reading comprehension skills. Overall, the results strongly support the conclusion that RTM leads to better performance, deeper understanding, and stronger long-term learning compared to traditional teaching methods.

In order to provide the research reliability and validity, the semi-structured interviews with 4 questions were undertaken from 20 EFL learners, and they were used to confirm the effectiveness of using reciprocal teaching method in the experimental group. The questions in the table 2 helped us understand both the cognitive and emotional aspects of learning through RTM. Here are some excerpts from student interviews. The following excerpts present students' responses regarding the effects of RTM, their preferences, challenges, and choices when applying the four strategies of predicting, questioning, clarifying, and summarizing the text.

Table 2.

Interview results

1.What were the effects of using reciprocal reading activities in reading comprehension skill?	2. Which strategy did you prefer and why?	3. Which strategy was too difficult for you and why?	4.Would you prefer to use the RTM instead of traditional method of reading? Why?
Although I was not able to speak fluently, it was an effective approach. I enjoyed the discussion and communication with others, which helped me better understand the text and express my opinions. (5 students' responses	*I prefer summarizing, as it allows me to grasp the main idea more easily and improves my summarizing skills. (8 students' responses)*	*Predicting was the most difficult task for me. (10 students' responses) I found it challenging to make predictions based on only part of the text because they could be incorrect without knowing the whole passage. I also worried that others might not like my prediction.*	*I prefer the RTM because discussing and collaborating with team members helps me understand the article more easily. It is both fun and effective. (10 students' responses)*

Many students preferred summarizing because it helped them grasp the main ideas more easily. Others enjoyed the group discussions and said it helped them understand the text better. One student mentioned struggling with predicting because they felt unsure making assumptions without reading the full text. These responses give us valuable insight into how students perceive the method.

Reciprocal reading activities positively impacted students' reading comprehension skills. They helped identify main ideas, enhanced critical thinking, and made reading more engaging than traditional methods. Working in teams and discussing texts improved communication, problem-solving, and understanding, while also allowing students to fill gaps in their knowledge. The approach further supported vocabulary development, text analysis, and step-by-step reading through prediction, questioning, and clarification.

Students preferred summarizing the most, as it helped them understand the main idea and improve their summarizing skills. Clarifying was also useful for learning unfamiliar phrases and enhancing comprehension through teamwork. Questioning encouraged critical thinking, while prediction made reading more engaging and helped anticipate content.

Among the reciprocal reading strategies, predicting was reported as the most difficult, as it was challenging to make accurate predictions without reading the entire text, and participants worried that others might disagree with their predictions. Summarizing was also difficult for some students, particularly in expressing ideas clearly in English and writing accurate summaries. Questioning and clarifying posed challenges for a few participants, mainly when explaining unfamiliar content to others. However, some students found the approach overall easy to handle without major difficulties.

Most students preferred using the Reciprocal Teaching Method (RTM) over traditional reading methods. They found that discussing and collaborating with team members made it easier to comprehend texts, enhanced engagement, and improved reading, writing, and speaking skills. Some students also noted that RTM helps develop critical thinking and can be applied for independent learning. A few participants preferred the traditional method or a combination of both approaches, believing that combining methods fosters the growth of skills that are not yet fully developed.

DISCUSSION

Theoretically, John H. Flavell is considered the founder of metacognition research, having introduced and developed the concept extensively through his work. According to him the metacognitive theory explains human mental thinking process (Concept of metacognition). A researcher Mohammad Reza explained reading comprehension strategies that readers use reading comprehension strategies, both cognitive and metacognitive, to better understand reading texts

and in order to learn to read independently in the frame of metacognitive theory (Ahmadi, 2016). The theoretical insights introduced by these scholars provide a basis for interpreting our results as bellowed.

Strategies	Experimental group's average	Control group's average	Interview result	
Predicting	86.6%	66%	Q1	RTM was effective.
Questioning	93.3%	83.3%	Q2	Prefer summarizing even it was difficult.
Clarifying	80%	75%	Q3	Most difficult was prediction
Summarizing	86.7%	66.7%	Q4	Yes

The MRT-based group outperformed the traditionally taught group, indicating that MRT effectively enhances reading comprehension. Consistent with metacognitive theory, this result suggests that learners improve their reading comprehension more effectively when instructional methods encourage them to think actively, monitor their understanding, and use cognitive and metacognitive strategies.

CONCLUSION

Based on the findings of this study, reciprocal teaching has a significantly positive effect on the English reading comprehension and metacognitive reading strategies of students.

Reciprocal teaching is one of the reading strategy instructions that improve readers' metacognitive awareness. It leads students to think about their reading process, develop a plan of action, monitor their own reading in order to construct their own knowledge, and self-evaluate their reading process.

Reciprocal teaching can help students become more aware of metacognitive strategies through explicit instruction with social interaction, so they can learn gradually and control their own learning process.

Thus, reciprocal teaching should be taken into consideration in order to adapt its implementation in the English reading class.

References

1. Ahmadi, M. R. (2012). Reciprocal Teaching Strategies and Their Impacts on English Reading Comprehension. *Theory and Practice in Language Studies, Vol. 2, No. 10*, 2053-2060.

2. Ahmadi, M. R. (2016). *The effects of reciprocal teaching strategy on reading comprehension, motivation and metacognition among Iranian EFL university learners.* University of Sains Malaysia.

3. Alsaraireh, M. Y. (2016). The Effect of the Reciprocal Teaching Model on Developing Jordanian Students' Reading Comprehension at Mutah University. *International Journal of Linguistics*, 69-93.

4. ARISTA, V. R. (2024). THE EFFECTIVENESS OF RECIPROCAL TEACHING STRATEGY TO ENHANCE STUDENTS' READING COMPREHENSION AND VOCABULARY MASTERY.

5. Chou, I.-C. (2016, 5). Helping Students Learn in EMI Courses Using Reciprocal Teaching: A Case Study of a Taiwan University. *Asian Education Studies*, 37-43. doi:DOI:10.20849/aes.v1i2.57

6. *Concept of metacognition*. (n.d.). Retrieved from Communication theory: https://www.communicationtheory.org/concept-of-metacognition-john-hurley-flavell/

7. English, T. (2025, December). *Cambridge English*. Retrieved from https://www.cambridgeenglish.org/test-your-english/: https://www.cambridgeenglish.org/test-your-english/

8. Gilakjani, M. R. (2012). Reciprocal teaching strategies and their impacts in English reading comprehension. *Theory and Practice in Language Studies*, 2053-2060.

9. Islam, S. (2020, June 1). Implementing reciprocal teaching method in.

10. Islam, S. (2020, June 1). IMPLEMENTING RECIPROCAL TEACHING METHOD IN.

11. Ku Mohd Nabil Ku Hamid, M. Y. (2016). The Effect of the Reciprocal Teaching Model on Developing Jordanian Students' Reading Comprehension at Mutah University. *International Journal of Linguistics*, 69-91. doi:doi:10.5296/ijl.v8i6.10448

12. Kurniawan Arif Maspul. (February 2024). ENHANCING READING INSTRUCTION WITH RECIPROCAL TEACHING: A FOCUS ON TECHNOLOGY INTEGRATION. *GLOBAL: Education Language and Humanity Journal*, Vol.1, No.2, pp. 66~74.

13. Oczkus, L. D. (2018). *Reciprocal teaching at work Powerful strategies and lessons for improving reading comprehension.* ASCD.

14. Peter E.Doolittle, D. H. (2006). Reciprocal Teaching for Reading Comprehension in Higher Education: A Strategy for Fostering the Deeper Understanding of Texts. *International Journal of Teaching and Learning in Higher Education*, 106-118.

15. Phuong, N. T. (2022). Teachers' Strategies in Teaching Reading Comprehension . *International Journal of Language InstructionVol. 1; No. 1; 2022*, 20-28.

16. Prastyo, M. &. (2017). Applying reciprocal method in teachng reading. *Studies linguistics and Literature*, 112-121.

17. Qurrotul Ayun, M. Y. (2017, November 2). The efficacy of reciprocal teaching method in teaching reading comprehension to EFL students. Indonesia.

18. Rojabi, A. R. (2021). Exploring reciprocal teaching method on EFL learners' reading comprehension. *Voices of English Language Education Society*, 132-142.

19. Rojabi, A. R. (2021, October). Exploring Reciprocal Teaching Method on EFL Learners' Reading Comprehension. Indonesia.

20. Teens, B. C. (2025). *British Council Learn English*. Retrieved from https://learnenglishteens.britishcouncil.org/skills/reading/b1-reading/how-be-safe-smart-searcher

21. Ting Pick Dew, S. S. (2021, May 09). The effectiveness of reciprocal teaching as reading comprehension intervention: A systematic review. Sabah, Malaysia. Retrieved from //dx.doi.org/10.24200/jonus.vol6iss2pp156-184

22. Wimonphon Rawengwan, R. Y. (2020). Reciprocal Teaching Method for Enhancing Thai EFL Learners' Reading Comprehension Ability. *Sripatum Review of Humanities and Social Sciences Vol. 20 No.*, 106-123.

23. Yunus, Q. A. (2017). The efficacy of reciprocal teaching method in teaching reading comprehension to EFL students. *ELT-Echo*, 134-146.

ІННОВАЦІЙНІ МОДЕЛІ МОВНОЇ ПОВЕДІНКИ УКРАЇНСЬКОЇ МОЛОДІ. ГІБРИДНІСТЬ І КРЕАТИВНІСТЬ

Кондратенко Н.Ю.
Кандидат педагогічних наук, доцент
Волкотруб Г.Й.
Кандидат філологічних наук, доцент
Заболотня Р.В.,
Воропай І.В.
Державний університет інформаційно-комунікаційних технологій
м.Київ, Україна

INNOVATIVE MODELS OF LANGUAGE BEHAVIOR AMONG UKRAINIAN YOUTH: HYBRIDITY AND CREATIVITY

Kondratenko N.
PhD in Pedagogy, Associate Professor
Volkotrub H.
PhD in Philology, Associate Professor
Zabolotnia R.,
Voropai I.
State University of Information and Communication Technologies,
Kyiv, Ukraine
DOI: 10.5281/zenodo.18084496

АНОТАЦІЯ

У статті розглядаються сучасні інноваційні моделі мовної поведінки української молоді в умовах соціокультурних трансформацій та глобалізаційних процесів. Особлива увага приділяється феномену мовної гібридності, що проявляється у поєднанні української, російської, англійської мов та молодіжного сленгу, а також у формуванні нових лінгвокреативних стратегій комунікації. Автори досліджують, як цифрові медіа, соціальні мережі та нові форми міжособистісної комунікації впливають на мовні практики молоді, сприяючи появі креативних мовних моделей, адаптованих до конкретного соціокультурного контексту.

Дослідження базується на комплексному підході, що передбачає використання кількісних і якісних методів аналізу мовної поведінки, включаючи анкетування, спостереження та аналіз текстів у соціальних мережах. Результати демонструють існування нових типів мовних практик, які поєднують елементи різних мов і стилів, формуючи унікальні гібридні моделі спілкування. Зокрема, визначено закономірності використання лексичних та граматичних інновацій, сленгових конструкцій і креативних мовних засобів, що свідчать про високий рівень лінгвістичної адаптивності та інноваційності сучасної молоді.

Особливу увагу приділено соціокультурним чинникам, які сприяють формуванню мовної креативності, зокрема впливу глобалізації, медіа, освітніх практик та міжкультурної комунікації. Стаття демонструє, що гібридність і креативність у мовленні молоді не лише відображають сучасні соціокультурні зміни, але й виступають інструментом самовираження та ідентичності.

Отримані результати мають значення для лінгвістики, педагогіки та медіакомунікацій, оскільки вони дозволяють розробляти ефективні освітні програми, спрямовані на розвиток комунікативної компетентності, а також формувати політику підтримки української мови у цифровому та соціальному просторі. Стаття відкриває перспективи для подальших досліджень мовної поведінки молоді в умовах гібридності та швидких соціокультурних трансформацій.

ABSTRACT

This article explores innovative models of language behavior among Ukrainian youth, focusing on hybridity and linguistic creativity. The study examines how young people combine Ukrainian, Russian, English, and contemporary slang in their everyday communication, reflecting broader socio-cultural transformations and globalization. Special attention is given to creative language strategies that emerge in digital media, social networks, and other contemporary forms of interpersonal communication.

The research employs a mixed-method approach, including surveys, observation, and the analysis of texts in social media, to identify patterns of language use. The findings reveal the emergence of hybrid linguistic models that integrate elements of different languages and styles, highlighting the adaptive and innovative nature of youth communication. Lexical and grammatical innovations, slang constructions, and creative linguistic practices demonstrate a high level of linguistic flexibility and inventiveness.

The study also considers socio-cultural factors that influence language creativity, including globalization, media exposure, educational practices, and intercultural communication. Hybridity and creativity in youth language are shown to serve not only as markers of social and cultural change but also as tools for self-expression and identity formation.

These results have implications for linguistics, education, and media studies, offering insights for developing programs to enhance communicative competence and support the Ukrainian language in digital and social contexts. The article also provides directions for future research on language behavior in hybridized and rapidly changing social environments.

Ключові слова: мовна поведінка, українська молодь, гібридність, лінгвокреативність, інноваційні мовні моделі, соціокультурні трансформації, цифрові медіа, комунікативна компетентність.

Keywords: language behavior, Ukrainian youth, hybridity, linguistic creativity, innovative language models, socio-cultural change, digital media, communicative competence.

Вступ

Сучасна українська молодь живе в умовах активних соціокультурних змін і глобалізаційних процесів, що значною мірою впливають на мовну поведінку. Нові форми комунікації, поширення цифрових медіа та соціальних мереж, а також постійне міжкультурне взаємодія сприяють появі нестандартних мовних практик, які поєднують різні мовні коди, стилі та сленгові форми. У таких умовах виникає потреба в системному дослідженні того, як молодь створює власні інноваційні моделі мовної поведінки, демонструючи гібридність і лінгвокреативність.

Мета цього дослідження полягає у виявленні та аналізі сучасних моделей мовної поведінки української молоді з акцентом на прояви гібридності та творчого використання мови. Для досягнення цієї мети було поставлено такі завдання:

1. Окреслити теоретичні основи дослідження мовної поведінки та лінгвокреативності.
2. Визначити ключові чинники, що впливають на мовну гібридність та креативність у мовленні молоді.
3. Дослідити конкретні приклади мовних практик молоді у сучасному соціокультурному та цифровому просторі.
4. Проаналізувати отримані дані з метою формулювання висновків щодо закономірностей та тенденцій розвитку мовної поведінки молодого покоління.

Таке дослідження дозволяє глибше зрозуміти сучасні комунікативні стратегії молоді, оцінити вплив глобалізаційних і локальних факторів на мовну поведінку та запропонувати практичні рекомендації для розвитку комунікативної компетентності в умовах швидких соціокультурних трансформацій.

Теоретичні основи дослідження

Поняття «мовна поведінка», «гібридність» та «лінгвокреативність».

У рамках сучасної соціолінгвістики «мовна поведінка» розглядається не просто як індивідуальний акт мовлення — це сукупність мовних рішень і стратегій, які людина застосовує залежно від соціального контексту, комунікативної мети, мовної спільноти чи співрозмовників. Тобто мовна поведінка — це спосіб, у який мовці адаптують вибір мови, стилю, коду чи варіанту в залежності від ситуативних чинників. [2]

У контексті молодіжної комунікації часто спостерігається явище мовної «гібридності». Це означає, що носії комбінують елементи різних мов, стилів, кодів: наприклад, українську, англійську, молодіжний сленг чи інтернет-жаргон. Така гібридність — свідомий вибір, часто пов'язаний з прагненням комунікативної гнучкості, ідентичності або належності до певної групи. Аналогічні явища описані в дослідженнях, присвячених «code-switching» і «code-mixing» серед молоді в мультикультурному і мультимовному середовищі. [4]

Під «лінгвокреативністю» розуміємо здатність молодих носіїв мови генерувати нові мовні форми — неологізми, метафори, фразеологізми, словотворчі експерименти, нові стилістичні й контекстуальні варіанти. Це прояв творчого підходу до мови, коли вона виступає не просто засобом передачі інформації, а інструментом самовираження, ідентифікації, креативної саморефлексії. У лінгвокреативності поєднується як елемент індивідуального стилю, так і колективної молодіжної практики.

Отже, у цій статті ми розглядаємо мовну поведінку молоді як комплексну, соціально зумовлену практику, в якій гібридність і лінгвокреативність — ключові характеристики сучасних мовних моделей.

Роль соціальних мереж, цифрових комунікацій та медіа у формуванні мовних практик молоді

У XXI столітті цифрове середовище — соціальні мережі, месенджери, блог-платформи та медіа — стало одним із головних просторів комунікації молодих поколінь. Ці платформи створюють особливі умови для формування та поширення нових мовних практик. Молодь, спілкуючись онлайн, часто комбінує різні мови, стилі, кодові ресурси — що значною мірою сприяє розвитку гібридності. Наприклад, у дослідженнях «digital sociolinguistics» описані випадки, коли молоді користувачі на Instagram або TikTok використовують змішання мов (code-switching / code-mixing) як засіб ідентичності, гумору чи групової належності. [4]

Крім того, медіа (онлайн=ЗМІ, відео- та блог-платформи, стримінгові сервіси) впливають на мовні норми, вводять нову лексику, неологізми, сленг, адаптований до глобальних трендів. Через медіа молодь отримує мовні моделі, які вона може адаптувати, змінити, переформулювати — і в процесі цих звернень народжуються нові, творчі мовні форми.

Цифрові комунікації стимулюють експерименти зі структурою мови, стилем, кодами й форматами: месенджер-чат, коментар, пост, мем, емодзі, уркаїнізований англійський сленг — усе це стає частиною сучасного мовного репертуару. Таким чином, медіа й цифрові простори не просто відображають — вони активно формують нову, гібридну та креативну мовну поведінку молоді.

Саме тому дослідження мовної поведінки молодих українців має враховувати роль соціальних мереж, медіа та цифрових комунікацій як ключових чинників, що визначають характер, динаміку та напрямки мовних змін.

Нижче подаю **один із методів збору даних**, а також **приклад таблиці**, де порівнюється українська, англійська та молодіжний сленг. Після таблиці — **пояснення, як здійснюється аналіз** цього методу.

Метод збору даних: контент-аналіз мовлення у соціальних мережах.

Для дослідження мовної поведінки української молоді одним із найбільш ефективних методів є **контент-аналіз цифрових комунікацій** — постів, коментарів, чатів, коротких відеоповідомлень та сторіз у соцмережах (Instagram, TikTok, Telegram-чати, Facebook-групи, Reddit).

Цей метод дозволяє фіксувати **реальні мовні практики**, а не декларовані. Молодь природно використовує гібридність, перемикання кодів, сленг, інновації — і це чудово видно саме в цифровому середовищі.

У таблиці подано приклад того, як може виглядати зібрана інформація: виокремлюємо конкретні мовні одиниці та порівнюємо їхні відповідники.

Українська форма	Англійська форма	Студентський / молодіжний сленг
привіт	hi / hello	хай, хелоу, привітульки
дякую	thanks / thank you	тенкс, сенкью, дяк, спасіб
я не встигаю	I'm running out of time	я не вигрібаю, не встигаю взагалі, я в мінусах
відпочивати	to chill / to relax	чілити, релаксити, чіл
дуже круто	awesome / great	топ, крінж/антитоп (контекстуально), пушечно
зустрінемось пізніше	see you later	побачимось потім, побачимось позже (гібрид), суа
повідомлення	message	меседж, мсг, смска, мемка (у деяких контекстах)
мені байдуже	I don't care	мені пофіг, по барабану, idc
неймовірно	incredible	нереально, крейзі, інкрідебл
жартувати	to joke	рофлити, мемити, прикалуватись

Приклад лінгвокреативної практики у спілкуванні молоді, приклад фрагмента діалогічного мовлення (умовний, але типовий):

Студент А: Я сьогодні такий *overloaded*, що мозок просто *рефрешу* не робить.

Студент Б: Та я тебе розумію. Я теж *залип* на завданні і вже *no ideas at all*.

Студент А: Думаю, треба трохи *почілити*, бо я скоро реально *вибухну*.

Студент Б: Та давай. Бо в нас ще купа всього, а я вже *не вигрібаю*.

Цей приклад — саме лінгвокреативна практика тму, що:

1. Гібридність мовлення

Молодь одночасно використовує українські слова (*я тебе розумію, не вигрібаю*) та англіцизми (*overloaded, no ideas at all, refresh*), що демонструє перемикання кодів.

2. Креативна адаптація іншомовних слів

- *рефрешу не робить* — англійський термін **refresh** вжито в українській граматичній формі;
- *почілити* — словотвірна адаптація від англ. **to chill**;
- *залип на завданні* — український молодіжний неологізм із переносним значенням.

3. Нові лексичні конструкції

- *no ideas at all* — англомовний фрагмент у середині української фрази;
- *я не вигрібаю* — емоційно-оцінний молодіжний вираз, що набув нової семантики «не справляюся».

4. Стратегія емоційного вираження

Лінгвокреативність тут працює як спосіб:

- підсилення емоцій,
- демонстрації дотепності,
- формування «свого» групового стилю.

Наведений діалог демонструє поєднання українських, англійських та молодіжних слів, що створює гібридну комунікативну модель. Молодь творчо адаптує іншомовні запозичення відповідно до української граматики (*почілити, рефрешу не робить*), формуючи нові словотвірні моделі. Такі конструкції використовуються для емоційного вираження, групової ідентифікації та стислості у цифровій комунікації. Це підтверджує високу ступінь лінгвокреативності сучасної молоді та її здатність до мовних інновацій.

Соціокультурні чинники, що впливають на мовну гібридність і креативність, та їх значення для розвитку комунікативної компетентності

Мовна гібридність і креативність сучасної української молоді формуються під впливом кількох ключових соціокультурних чинників, які визначають характер її комунікації та динаміку мовних змін. Насамперед ідеться про середовище цифрової взаємодії, адже саме соціальні мережі та медіаплатформи створюють простір, де поєднуються різні мовні моделі, культурні коди й стилістичні традиції. Постійний контакт із глобальним інформаційним потоком сприяє природному включенню іншомовних елементів у щоденне спілкування, а також стимулює експерименти з новими формами висловлювання. [5]

Важливим чинником є й відкритість молоді до міжкультурної взаємодії: навчання за кордоном, міжнародні проєкти, дистанційні формати роботи та участь у глобальних онлайн-спільнотах

створюють природні умови для перемикання між мовами та формування гібридних комунікативних стратегій. Такі процеси посилюються загальною тенденцією до мобільності та цифрової самопрезентації — молоді люди прагнуть бути включеними в ширший культурний простір і використовують мовні засоби як інструмент адаптації та самовираження.

Окремо варто зазначити роль зміни ціннісних орієнтацій молодого покоління. Сучасна молодь схильна до індивідуалізації, творчої свободи та гнучких форм комунікації, що природно відображається у мові: виникають нестандартні словотвірні моделі, нові контекстуальні значення, скорочення та гібридні конструкції. Мовна креативність стає важливою складовою особистісної ідентичності, а також способом належності до своєї групи чи спільноти.

Усі ці соціокультурні чинники безпосередньо впливають на розвиток комунікативної компетентності молоді. Гібридність і креативність розширюють мовний репертуар, роблять спілкування більш гнучким, адаптивним і ситуативно доречним. Молодь легко перемикається між мовами, стилями та форматами комунікації, що є важливою навичкою в умовах глобалізованого середовища. Креативне використання мови сприяє кращому розумінню комунікативного контексту, підвищує здатність точно передавати нюанси змісту та емоцій, а також формує медійну й міжкультурну грамотність.

Таким чином, соціокультурні процеси не лише змінюють мовну поведінку молодого покоління, але й впливають на формування нового типу комунікативної компетентності — гнучкої, багатокодової, адаптивної та орієнтованої на різноманітні форми взаємодії в сучасному світі.

Висновки

Проведене дослідження засвідчило, що мовна поведінка сучасної української молоді формується на перетині кількох ключових тенденцій — соціокультурних змін, глобалізаційних впливів та швидкої диджиталізації комунікаційного простору. Саме ці чинники створюють підґрунтя для мовної гібридності та лінгвокреативності, які сьогодні виступають не маргінальними, а системними характеристиками молодіжного мовлення.

Аналіз теоретичних підходів і зібраних мовних матеріалів показав, що гібридні мовні моделі та творчі стратегії в мовленні молоді виконують низку важливих функцій: вони сприяють самовираженню, забезпечують гнучкість комунікації в різних соціальних середовищах, полегшують включення у глобальний інформаційний простір і водночас залишають місце для актуалізації національно-культурної ідентичності. Мовна креативність проявляється не лише у формуванні нових слів чи стилістичних прийомів, а й у здатності молодої людини керувати кількома мовними кодами залежно від ситуації, аудиторії й комунікативної мети.

Особливо помітну роль відіграють соціальні мережі та цифрові платформи, які виступають не просто середовищем для обміну інформацією, а простором формування нових мовних норм. Саме тут найактивніше відбуваються експерименти зі змішуванням стилів, мов і регістрів, продукуються нестандартні мовні рішення, трансформуються традиційні комунікативні моделі. Ці процеси не є хаотичними — вони мають внутрішню логіку, обумовлену потребою молоді у швидкому, гнучкому та емоційно насиченому спілкуванні.

Отримані результати дають змогу стверджувати, що мовна гібридність і лінгвокреативність молоді не підривають мовної системи, а навпаки — свідчать про її адаптивність і здатність до розвитку. Вони формують нові підходи до комунікативної компетентності, де поряд із нормативними знаннями важливими стають міжкодовість, стилістична варіативність та вміння працювати з багатомовним цифровим середовищем.

Таким чином, осмислення цих процесів має важливе значення не лише для лінгвістики, а й для освіти, медіасфери та культурної політики. Розуміння молодіжної мовної динаміки дозволяє не лише фіксувати зміни, а й передбачати напрями мовного розвитку, формувати сучасні підходи до мовної освіти й підтримувати живу еволюцію української мови в умовах глобальних трансформацій.

Література

1. Дибок С. Є. Молодіжний сленг як засіб комунікації [Електронний ресурс] // *Україна і світ: гуманітарно-технічна еліта та соціальний прогрес: матеріали міжнар. наук.-теорет. конф. студентів і аспірантів, 14–15 квітня 2021 р.* / ред. кол.: В. М. Скляр та ін. ; Нац. техн. ун-т «Харків. політехн. ін-т». – Харків, 2021. – С. 590–592. – Режим доступу: http://repository.kpi.kharkov.ua/handle/KhPI-Press/62336.

2. Грабовий П. Український молодіжний сленг як лінгвокультурний феномен // *Компаративні дослідження слов'янських мов і літератур. Пам'яті академіка Леоніда Булаховського*. – 2010. – № 11. – С. 34–38.

3. Кондратюк О. Молодіжний сленг як мовне явище // *Ї: незалежний культурологічний часопис*. – 2005. – № 38. – Режим доступу: http://www.ji.lviv.ua/n38texts/38-zmist.htm.

4. Марія Р., Далі С. З. М., Хассан Н. Соціальні мережі та стратегії брендингу в закладах вищої освіти [Текст] // *International Journal of Educational Management*. – 2020. – Vol. 34, No. 5. – P. 833–850.

5. Руденко М. Сучасний молодіжний соціолект: тенденції розвитку та характерні риси // *Науковий вісник Міжнародного гуманітарного університету. Серія: Філологія*. – 2022. – № 58. – С. 130–139.

РОЗВИТОК КУЛЬТУРИ УКРАЇНСЬКОГО ПРОФЕСІЙНОГО МОВЛЕННЯ У ФАХОВІЙ ПІДГОТОВЦІ СТУДЕНТІВ

Стежко С.О.
Кандидат філологічних наук, доцент
Кравченко В.І.
Кандидат технічних наук, доцент
Кондратенко Н.Ю.
Кандидат педагогічних наук, доцент
Мелешко Т.В.
Кандидат технічних наук
Ситник Л.В.
Державний університет інформаційно-комунікаційних технологій
м.Київ, Україна

DEVELOPMENT OF UKRAINIAN PROFESSIONAL LANGUAGE COMPETENCE IN HIGHER EDUCATION STUDENTS

Stezhko S.
PhD in Philology, Associate Professor
Kravchenko V.
PhD in Technical Sciences, Associate Professor
Kondratenko N.
PhD in Pedagogy, Associate Professor
Melesko T.
PhD in Technical Sciences
Sytnik L.
State University of Information and Communication Technologies
Kyiv, Ukraine
DOI: 10.5281/zenodo.18084515

АНОТАЦІЯ

У статті розглянуто особливості формування культури українського професійного мовлення студентів технічних і юридичних закладів вищої освіти. Акцентовано на значенні офіційно-ділового стилю як універсального комунікативного інструмента, що забезпечує точність, логічність і нормативність професійного висловлення незалежно від галузі підготовки. Для майбутніх інженерів опанування культури мовлення є необхідною умовою коректного використання термінології, складання технічної документації та ефективної взаємодії у спільних проєктах. Для студентів-правників мовна компетентність визначає якість аргументації, здатність до чіткого формулювання правових позицій, підготовки процесуальних документів і ведення ділової комунікації.

Підкреслено, що розвиток професійного мовлення має ґрунтуватися на системному опрацюванні автентичних текстів, моделюванні фахових ситуацій, формуванні термінологічної грамотності та практиці створення документів різних жанрів. Визначено, що інтеграція мовної підготовки в міждисциплінарний простір сприяє підвищенню рівня комунікативної культури студентів, формує їхню здатність відповідально й точно відтворювати зміст професійної інформації, дотримуватися мовного етикету та представляти фахове середовище на належному рівні. Розвиток культури українського професійного мовлення розглядається як невід'ємна складова якісної підготовки майбутніх інженерів і юристів, що забезпечує їхню професійну ефективність і конкурентоспроможність.

ABSTRACT

The article examines the specific features of developing the culture of Ukrainian professional communication among students of technical and law higher education institutions. The emphasis is placed on the significance of the official-business style as a universal communicative tool that ensures precision, logical coherence, and adherence to linguistic norms in professional expression, regardless of the field of training. For future engineers, mastering professional language culture is essential for the correct use of technical terminology, preparation of documentation, and effective interaction within project teams. For law students, linguistic competence determines the quality of argumentation, the ability to formulate legal positions clearly, prepare procedural documents, and conduct professional communication.

The study highlights that the development of professional communication skills should be based on systematic work with authentic texts, modelling of professional situations, formation of terminological literacy, and practice in producing documents of various genres. It is noted that integrating language training into the interdisciplinary educational space enhances students' communicative culture, strengthens their ability to accurately convey professional information, observe linguistic etiquette, and represent their professional field appropriately. The development of Ukrainian professional communication culture is viewed as an integral component of high-quality

training for future engineers and legal professionals, contributing to their professional effectiveness and competitiveness.

Ключові слова: українська мова; професійне мовлення; офіційно-діловий стиль; студенти; технічні спеціальності; юридична освіта; термінологія; комунікація; компетентність.

Keywords: Ukrainian language; professional communication; official-business style; students; technical specialities; legal education; terminology; communication; competence.

Вступ

Сучасні трансформації у сфері вищої освіти України визначають необхідність посилення ролі української мови як інструмента професійної комунікації в різних галузях підготовки. Зростання вимог до якості фахової діяльності майбутніх спеціалістів — як технічного, так і юридичного профілю — актуалізує потребу формування в студентів високої культури професійного мовлення, що забезпечує точність, нормативність і відповідальність у передачі інформації. Для технічних спеціальностей мовна компетентність пов'язана з коректним використанням термінології, підготовкою технологічної документації та чітким фіксуванням результатів інженерних рішень. Для юристів володіння професійним мовленням є основою складання правових текстів, аргументації позицій, ведення офіційної комунікації та представлення інтересів сторін у правовому полі.

Необхідність цілеспрямованого розвитку культури професійного мовлення зумовлена не лише освітніми вимогами, а й загальнонаціональними процесами зміцнення статусу української мови як державної. Від рівня мовної підготовки студентів залежить якість майбутньої професійної діяльності, ефективність комунікації, здатність працювати з офіційними текстами та створювати власні документи відповідно до мовних і правових норм. У цьому контексті важливим є поєднання теоретичних знань із практичним опануванням мовленнєвих умінь, що забезпечує інтеграцію мовної складової у фахову підготовку.

Постановка проблеми

У сучасних умовах розвитку освіти в Україні важлива не лише фахова підготовка студентів-інженерів чи студентів-юристів, а й формування в них належної мовної компетентності державною — українською — мовою. З одного боку, згідно з Закон України «Про освіту», мовою навчання у вузах має бути державна мова, що гарантує право кожного громадянина на освіту державною мовою. [1] З іншого боку, в реальному освітньому процесі — особливо в технічних і юридичних закладах — надто часто недостатньо уваги приділяється розвитку офіційно-ділового та професійного мовлення українською. Це призводить до ситуацій, коли студенти, навіть після здобуття фахової освіти, не мають достатніх комунікативних навичок для складання документації, професійного листування або участі у публічних дискусіях державною мовою.

Таке становище є невідповідним як з вимог законодавства, так і з викликами часу, адже формування професійної комунікативної культури — обов'язкова умова якісної підготовки фахівця. Крім того, у суспільному контексті утвердження української як державної мови набуває особливої ваги, а недостатня мовна підготовка майбутніх спеціалістів може негативно вплинути на професійну репутацію, ефективність комунікації та загальний рівень культури мовлення.

Таким чином, існує проблемна ситуація: недостатність системного й цілеспрямованого підходу до формування культури українського професійного мовлення у студентів технічних і юридичних спеціальностей, що призводить до зниження якості їхньої комунікативної підготовки та обмежує можливості повноцінної професійної самореалізації.

Мета дослідження

Метою цього дослідження є **аналіз та обґрунтування педагогічних умов, методів і засобів, спрямованих на ефективне формування культури українського професійного мовлення у студентів технічних і юридичних закладів вищої освіти**, з урахуванням нормативно-правового забезпечення та специфіки мовних вимог професійної діяльності.

У межах цієї мети передбачено:

- виявити складові професійної мовленнєвої компетентності, що є критичними для фахової підготовки інженерів і юристів;
- дослідити існуючі підходи до навчання українському офіційно-діловому та професійному мовленню;
- запропонувати методичні та організаційні рекомендації для інтеграції професійно-мовних навичок у навчальні програми;
- окреслити шляхи підвищення мовної культури студентів як одного з компонентів їхньої загальної професійної компетентності.

Обґрунтування актуальності

- Законодавча база: Закон «Про освіту» встановлює державну українську як мову освіти, що покладає відповідальність на заклади вищої освіти щодо мовної підготовки студентів [2]. Соціокультурний контекст: Становлення української мови як державної та її вжиток у всіх сферах — від науки до управління — є важливим чинником національної ідентичності та професійної самосвідомості [1].
- Професійна доцільність: Для інженерів і юристів володіння нормативним українським професійним мовленням — це інструмент точного формулювання, ділового спілкування та документування, що відображає рівень професійної культури та компетентності [4].

Нижче подаю **невеличке науково обґрунтоване порівняльне дослідження**, у якому чітко простежено відмінності у мовленнєвих потребах, функціях та професійних вимогах інженерів і юристів.

Порівняльне дослідження мовленнєвих особливостей майбутніх інженерів та юристів

Професійне мовлення студентів технічних та юридичних спеціальностей формується під впливом різної специфіки професійної діяльності, що зумовлює відмінності у змісті, структурі та функціях мовлення. Незважаючи на спільну вимогу до володіння нормативною українською мовою, характер їхньої комунікації, типи документів та термінологічний апарат суттєво різняться.

1. Структурні та функційні особливості мовлення

Інженери використовують мову переважно як інструмент фіксації технічної інформації. Їхнє мовлення характеризується точністю, однозначністю, прагматичною спрямованістю та мінімізацією емоційності. Основне завдання — зафіксувати параметри, описати процеси, передати логічну послідовність дій, уникнути різночитань. Тому інженерна комунікація ґрунтується на стандартизованих формах, структурованих документах і домінуванні термінів, що мають суворо визначене значення.

Юристи, натомість, працюють у сфері, де мова виконує не лише інформативну, а й регулятивну, аргументативну й інтерпретаційну функції. Їхнє мовлення включає складні синтаксичні конструкції, юридичні дефініції, посилання на нормативні акти та логічні схеми міркування. На відміну від інженерів, юристи оперують мовою як засобом впливу, переконання та захисту позиції, тому їхня комунікація повинна бути логічно бездоганною, юридично коректною та риторично виваженою.

2. Термінологічна компетентність

У технічній сфері термінологія є здебільшого стабільною, стандартизованою й орієнтованою на міжнародні норми. Інженерні терміни часто мають однозначне тлумачення, що сприяє уникненню неправильної інтерпретації при описі технічних процесів. Термінологічна система відносно замкнена й чітко структурована.

У юридичній сфері терміносистема значно динамічніша. Юридичні терміни можуть мати кілька рівнів значення — законодавче, доктринальне та практичне. Крім того, юридичні поняття потребують контекстуальної інтерпретації, оскільки зміст часто залежить від конкретної правової ситуації, галузі права або судової практики. Тому термінологічна компетентність юриста включає не тільки знання термінів, а й уміння тлумачити їх відповідно до правової норми.

3. Типи професійних текстів

Інженерні тексти:

- технічні звіти,
- інструкції та регламенти,
- технологічні карти,
- креслення з описами,
- проєктна документація.

Ці документи будуються за суворими стандартами [3], мають чітку структуру й мінімальний простір для інтерпретацій.

Юридичні тексти:

- позовні заяви,
- договори,
- висновки та довідки,
- процесуальні документи,
- правові позиції та аналітичні довідки.

Юридичні тексти передбачають складні синтаксичні конструкції, нормативні посилання, пояснювальні елементи та формально-логічні зв'язки.

4. Особливості усного мовлення

Усне мовлення інженерів спрямоване на обговорення технічних рішень, презентацію проєктів та координацію командної роботи. Воно має бути лаконічним, структурованим і максимально точним, без багатозначності.

Усне мовлення юристів включає участь у дискусіях, публічних виступах, дебатах, переговорах. Тут важливими є аргументація, логічна послідовність, риторична майстерність і вміння адаптувати висловлення до аудиторії.

Порівняльна характеристика мовлення майбутніх інженерів та юристів:

Критерій порівняння	Мовлення інженерів	Мовлення юристів
Основна функція мовлення	Фіксація технічної інформації; опис процесів і характеристик; передання точних параметрів	Регулятивна, аргументативна, інтерпретаційна; формулювання правових позицій та вплив на адресата
Домінантні ознаки	Точність, лаконічність, однозначність, стандартизованість	Логічність, структурованість, нормативність, риторична виваженість
Термінологія	Стабільна, стандартизована, технічна, з перевагою однозначних термінів	Динамічна, контекстуально залежна, юридичні дефініції з можливими варіативними трактуваннями
Типові документи	Технічні звіти, інструкції, специфікації, креслення, проєктна документація	Договори, позовні заяви, процесуальні документи, юридичні висновки, аналітичні довідки
Характер усного мовлення	Короткі аргументовані пояснення, обговорення технічних рішень, координація дій	Публічні виступи, дискусії, переговори, аргументація правових позицій
Мовні вимоги	Чіткість, структурність, відсутність двозначності, дотримання технічних стандартів	Юридична точність, відповідність правовим нормам, логічна послідовність, дотримання етикету

Критерій порівняння	Мовлення інженерів	Мовлення юристів
Мовна мета	Забезпечення зрозумілості та коректності технічної інформації	Правильне застосування закону, переконання та вплив на прийняття рішень
Комунікативні ситуації	Технічні наради, презентації проєктів, розробка документації	Судові засідання, консультації, переговори, складання юридичних документів

Висновок

Отже, мовленнєва діяльність інженерів і юристів відрізняється як за структурою текстів, так і за функціями, метою та термінологічною специфікою. Для інженера мова є інструментом точного опису та фіксації інформації; для юриста — засобом правової інтерпретації, аргументації та впливу. Тому формування професійного мовлення у цих категорій студентів потребує диференційованих підходів і чіткої орієнтації на вимоги відповідних професійних середовищ.

Література

1. Закон України «Про освіту» № 2145-VIII від 05.09.2017. Відомості Верховної Ради України. Retrieved from https://zakon.rada.gov.ua/laws/show/2145-19

2. Закон України «Про забезпечення функціонування української мови як державної» № 2704-VIII від 25.04.2019. Відомості Верховної Ради України. Retrieved from https://zakon.rada.gov.ua/laws/show/2704-19

3. ДСТУ 4163:2020. Уніфікована система організаційно-розпорядчої документації. Вимоги до оформлення документів.

4. Компетентність саморозвитку фахівця: педагогічні засади формування у вищій школі. (2007). Ізмаїл: ІДТУ.

5. Підлісний Є. (2020). Реалізація педагогічних умов формування правової культури студентів в закладах вищої освіти. *Психолого-педагогічні проблеми сучасної школи*, 1(3), 119–126.

6. Басиста І. В., Йосифович Д. І. (2020). Підготовка фахівців у галузі "Право" закладами вищої освіти МВС України: історичні передумови, сучасний стан та перспективи. *Соціально-правові студії*, 1(7), 8–14.

7. Глазунова О. Г., Гуржій, А. М., Волошина Т. В., Корольчук В. І., Пархоменко О. В. (2020). Неформальна освіта майбутніх фахівців з інформаційних технологій: організація, контент, інструменти. *Фізико-математична освіта*, 1(23), 29–35.

SOCIAL SCIENCES

THE USE OF CHATGPT IN BUSINESS ADMINISTRATION EDUCATIONAL PROGRAM: A QUALITATIVE STUDENT STUDY

Zurashvili N.
Georgian International University
ORCID: 0009-0002-9706-7211
Mushkudiani Z.
Georgian International University
ORCID: 0000-0003-0987-3564
Zhozhuashvili N.
Georgian International University
ORCID: 0009-0008-4882-3467
Zurashvili N.
Georgian International University
Tbilisi, Georgia
DOI: 10.5281/zenodo.18084529

ABSTRACT

Artificial intelligence was the main reason for the change in the modern era. It was especially related to the educational field. Artificial intelligence gave teachers, lecturers, and researchers a superpower, initially to explore new information rapidly. After teachers and researchers, students and pupils were the segment that started using artificial intelligence for their benefit. ChatGPT is the tool which very popular in the whole world, cause it is a virtual assistant and has wide possibilities. Specially the main possibility is to generate information, to solve problems and analyzing information rapidly in minutes. Its popularity is increasing in Georgian students.

New technologies that simplify the working process are convenient and beneficial for teachers and students as well. Artificial intelligence has its own dark sides. It affects critical thinking. Students who rely excessively on artificial intelligence develop limited critical thinking.

There are many studies which investigate how artificial intelligence affects students ' problem-solving and critical thinking patterns in the academic field.

This study employed a qualitative research design to explore how undergraduate students in the Business Administration program at the Georgian International Universities (5 universities) use ChatGPT during their learning process. Data were collected through in-depth interviews with seventy students conducted between the first and the fifteenth of November. The following research reveals how students perceive the benefits and challenges of ChatGPT. The survey revealed whether students regard it ethically to use ChatGPT in their assignments.

The research showed how often students use ChatGPT to complete their homework assignments. What are the main issues that need to be addressed by ChatGPT? The participants of the survey showed that using ChatGPT is effective for several reasons, but the main reason is that it is very fast and can accumulate information quickly. Students trust ChatGPT, and sometimes they do not check the information to see if it is accurate. Students perceive that there is a risk of plagiarism when using ChatGPT. They can understand that too much using this tool can weaken their abilities of critical thinking and problem-solving.

The study concludes that ChatGPT provides meaningful support in the learning process but requires responsible and moderate use.

Keywords: ChatGPT, Business Administration, AI in Education, Student Learning, Ethics.

Literature review

Different authors have their opinions about the future of ChatGPT throughout the learning process. Scientists Ausat, Suherlan (2023) believe that ChatGPT is crucial during training process. This is caused by its ability to generate information in small amount of time. It concludes various resources [1]. The researchers consider ChatGPT as the future part of training and learning process due to its advantage abilities to solve complicated problems and create new context and comprehensive content based on basic ideas. Basir (2023) indicates that ChatGPT will become indivisible part of business administration programs. This result derives from the capability of ChatGPT to analyze in minutes long data about market, client information and behavior of the market [2].

Subagja (2023) considers ChatGPT as an unique virtual assistant. The unique characteristics give opportunities to the students and instructors to use it same effectively [3]. It can boost the experience of customer and an organization as well. Rane (2023) and Gremyr (2022) using ChatGPT throughout learning process in business administration can be effective, because the virtual assistant can give crucial information to the instructors to evaluate the students comprehensively, and offer to the students the assignments which are suited to their possibilities and knowledge the most [4].

Javaid (2023) suggests that ChatGPT can be used as analytical instrument. The Chatbot can make simulations and hypothetical conditions. It can be used as the best instrument for decision making [5]. It can identify and evaluate risks and opportunities of each situation. ChatGPT can create strategies for students and for

lecturers to establish appropriate courses depend on specific characteristics.

Omenazu (2022) considers that ChatGPT can be used as a tool for strategic decision-making. The scientist emphasises the importance of a virtual assistant, which can help organisations set their goals in both the long and short term [6]. The scientist indicates that after describing all aspects of the situation, which are risks, internal and external conditions, the decision-making strategy can be productive [7].

ChatGPT is a new technology, and there is limited research on the subject. Scientists are conducting several studies related to using ChatGPT in learning programs. Time is needed to observe the results and impacts of ChatGPT on educational programs and business administration.

Background

Digital technologies are changing all aspects of human life. New emerging technologies have a huge influence on society, influencing communication, education, business processes, and decision-making across all sectors. In the late years of civilisation, many new technologies have emerged, but among them, artificial intelligence had a dramatic influence on changing almost all aspects of human work. The starting point of ChatGPT, when the whole world was announced, was in 2022. Since this date, the Chatbot has been available for every citizen of the world, for free. As a human treat-based AI tool capable of generating, analysing, and synthesising information within seconds, ChatGPT has quickly become integrated into everyday academic and professional tasks [8].

Artificial intelligence has huge possibilities. At first, it is the skill to imitate the person who is communicating with. Imitation makes ChatGPT more familiar to its users. They are feeling trust and are open to sharing any information. Another aspect is that ChatGPT is very simple to use. It is accessible to every interested person, even for children who can use technology. ChatGPT seemed like a durable assistant that knows any information at any time.

An important issue is that ChatGPT helps its users to collect lots of information about various kinds of information very briefly and easily. It can analyse difficult texts in minutes, it can create photos. ChatGPT makes essays in minutes and performs other important academic work in minutes, which would take several hours for a human.

Higher education is one of the fields in which the impact of AI has been particularly visible. In higher education, ChatGPT is being used by students and lecturers rapidly. It has several reasons. ChatGPT is a great tool for students to generate immediate answers for their assignments. Chatbot helps students to analyse information in a short time. If a student has difficulty understanding the subject, it gives an opportunity to explain the theme using several methods. There are a lot of universities and colleges where the teaching process is going remotely. In this case, ChatGPT is almost the main tool for students who can't attend the remote lectures or the lecturer is not accessible to them.

Behind the benefits that ChatGPT give the students and lecturers, there are lot of challenges. The first issue that scientists indicate, according to ChatGPT usage in higher education, is the decline in the level of critical thinking of students, who intensively relied on ChatGPT in their learning process. The second main reason is that students can't solve their problems independently without ChatGPT anymore. This is an emerging problem, which is emphasised by many lecturers and teachers. There is no clear evidence of what results these challenges can have after graduating from universities, and in the work life of employees who use ChatGPT too often. To block ChatGPT completely is not the solution of the problem. There are several strategies which are accepted by the researchers. First and most important is to give an explanation and train students on how ChatGPT can be used ethically.

The business administration field is almost crucial in the modern era of civilisation. Business administration is the field where the critical thinking, independent decision making, adaptive and brief decisions are essentials. There is a high demand for the faculty of business administration by the students. This means that many students using AI through business administration program throughout learning process. It remains unclear how students perceive ChatGPT, what value they derive from using it, what challenges they encounter, and how AI influences their development of business-related competencies.

Students and academic staff in Georgia are also actively using ChatGPT within the educational process. The purpose of the present study is to examine and evaluate how students in the Business Administration program use ChatGPT during their learning activities.

This study aims to explore the use of ChatGPT among undergraduate Business Administration students at Georgian International University. The survey shows the results of a qualitative survey. The aim of the survey was to identify how students perceive ChatGPT, how often they are using the Chatbot, and what are the main concerns of their usage. The survey shows what beliefs have students toward ChatGPT limitations. If they consider using ChatGPT ethical is shown in the following article. The research reveals how AI assistant can impact on students' development in the academic or professional ways. In the following survey is described what strategies and tactics can be used by the instructors and lecturers to make ChatGPT impact less damageable.

Methods

In this survey is used qualitative research method. The main instrument of the survey was in – depth interview. The participants of the survey were undergraduate students, who are learning in the English – language business administration programs at Georgian International University. The survey was conducted in five international universities. Seventy students have participated through the survey. The interview was conducted face to face format. Each interview's average time was 40 minutes. The survey was conducted from 1 November to 30 November, 2025. The limitation of the survey was that participants were required to stay anonymous.

The aim of the research was to determine how business administration students use ChatGPT during the learning process, what benefits they perceive, what

challenges they face, and what opinions they have regarding the ethical use of ChatGPT.

The main research questions were:

How do students use ChatGPT in the learning process within the business administration program?

What benefits do students identify in using ChatGPT?

What challenges do students encounter during its use?

What are students' perceptions regarding the ethical use of ChatGPT?

What do students think about the impact of ChatGPT on the development of business skills?

The next sections will show the main results and answers to the research questions.

Result and Discussion

The wide accessibility of artificial intelligence (AI) to the general public quickly demonstrated how intensively university students would begin using AI tools. One of the most popular AI systems worldwide is OpenAI's ChatGPT chatbot, which became freely available to the public on 30 November 2022.

There are several reasons behind the growing popularity of AI and the increasing use of ChatGPT among students. First, the communication style of AI mimics the manner of a direct interlocutor. The virtual assistant enables users to create emails, write essays, generate various types of code needed for website development, solve mathematical problems, write motivational letters, analyse digital materials, interpret texts, and much more [9].

From the very beginning, certain risks associated with ChatGPT also became evident, particularly in how students use the AI assistant in the process of completing academic assignments. These risks raised concerns about limitations on students' independent thinking and decision-making abilities [10].

Researchers quickly discovered that the use of AI in higher education is not a temporary trend but a fundamental transformation that will change the developmental trajectory of humanity. Since the emergence of AI, even teaching methodologies have changed. Some scholars argue that despite possible negative consequences, AI offers many undiscovered opportunities that could significantly simplify the learning process if used appropriately [11].

However, during the research process, it also became evident that despite its attractiveness, the information provided by AI may be superficial, artificial, and leave users with a sense of incompleteness [12].

The influence of ChatGPT is particularly visible among students in business administration programs. Through the virtual assistant, students can obtain any information related to business topics they find interesting. Concepts that may remain unclear during classroom lectures become easily understandable with the help of the virtual assistant. Notably, ChatGPT can explain the same information through situational scenarios and simulations, something lecturers are not always able to provide due to time constraints and large class sizes.

ChatGPT also allows business students to obtain brief summaries of various topics, highlighting key aspects. While this saves time, it may also deprive students of the opportunity to acquire deeper and more comprehensive knowledge about subjects that interest them.

Working with ChatGPT enables students to complete assignments without significant effort. Before the invention of AI tools, students had to read materials to complete their assignments, even if the quality was low. With AI, it is possible to complete tasks without reading the material at all.

It is easy to imagine how attractive this possibility can be for any student, being able to gain several free hours thanks to an AI assistant. On the other hand, using ChatGPT in this manner may be considered unethical and ineffective.

The irresponsible use of ChatGPT can create a range of problems for both students and, later, their employers. When students acquire superficial knowledge, they become overly dependent on AI assistants. Their analytical, synthetic, and critical thinking skills fail to develop because AI performs these functions for them. Strategic planning, strategic leadership, and understanding the importance of ethics in academic or professional settings are not adequately developed among such students.

In addition, content generated by ChatGPT—either information or essays—may carry a high risk of plagiarism, since AI lacks the individuality that is one of the key human advantages. The AI assistant may provide similar responses to different users, which increases the risk of plagiarism.

It is also important to note that although AI has access to thousands or even millions of files and pieces of information—far more than human memory allows—the content it generates may sometimes be inaccurate or incorrect, potentially misleading users. This is particularly relevant in relation to business processes [13].

Several studies have been conducted to assess the impact of ChatGPT on the learning process. Muhammad Abbas, Farooq Ahmed Jam, and Tariq Iqbal Khan conducted a study in 2024 involving 494 students, examining whether ChatGPT supports learning or has a negative impact. The results showed that when students experience academic overload or limited time, they significantly increase their use of ChatGPT. Students aiming for high academic performance tend to use it less. Those who work and lack time for assignments often rely on ChatGPT for assistance [14].

Another study conducted by Silvia Ortiz-Bonnin and Joanna Blahopoulou examined the academic appropriateness, ethics, risks, and dangers associated with ChatGPT. The study involved 468 students. The findings revealed that students who believed ChatGPT use might result in lower grades were less likely to use it. Similarly, students who considered its use unethical also tended to avoid it [15].

The survey was conducted by Nasr Rana in 2025. The main goal of the survey was to identify what kind of influence ChatGPT on critical thinking throughout the learning process. Forty students participated in the survey. The survey revealed the impact of Chatbot on

the students when they are searching and collecting information, when they are integrating all data and making decisions.

Results indicated that ChatGPT had a positive effect on the first three stages but a neutral effect on the final stage—where information synthesis and conclusion formation, requiring critical thinking and new idea generation, are necessary [16].

Scholarly research has also identified strategies that can help avoid the negative consequences of ChatGPT and promote its use as a supportive assistant that saves time and provides valuable information.

Results. The findings revealed that students began using ChatGPT early in their academic programs, motivated by its simplicity and accessibility. The researcher has revealed that using ChatGPT started immediately after starting the learning on business administration. The reason was that the lecturer asked the question, but nobody was able to answer appropriately. The student has decided to appear more vise and ask the same question to ChatGPT. As it is shown, there are some psychological reasons to use ChatGPT throughout the learning process. One main reason is to express yourself as the smartest person in the group.

In relation to the types of assignments for which students sought assistance, most reported using the AI assistant to complete tasks, conduct situational analyses, generate conclusions, and search for supplementary information. As one student explained, after completing an assignment, they would check their responses with ChatGPT to determine whether the chosen approach was appropriate. Even in cases where their answer differed from the AI-generated one, the student stated that they still preferred their own work.

When asked how ChatGPT contributed to their understanding of business and management concepts, students indicated that the tool provided useful explanations—particularly for topics requiring additional time or clarification, or when lectures were missed. Some students have explained that they strated using CharGPT on the business administration program, cause there were some subjects and issues they could not deal with. The Chatbot is free and available to ask anything anytime. They asked ChatGPT, and after the explanation, everything became clear and understandable for them. One participant has described that she had some difficulties to understand Miznberg's leadership roles. ChatGPT has become the only way to identify deeply the essence of the leadership roles. ChatGPT offered several simulations and practical situations, which made the concept sensed to the student.

ChatGPT benefits are wide and there is no way to avoid see the great outcomes derived from using Chatbot, but it has dark side as well. There are many limitations, which prevents students to use it more effectively. One specific issue is that, the information given by ChatGPT is very general. Very often it is not possible to concern the specific issue, due to generality of the data. Sometimes the information given by ChatBot is false and inaccurate. The high level of trust from the students can ruin the learning process and students learn inaccurate concepts and knowledge. According to the survey, several students reported that after searching information with ChatGPT, they suspected and discovered that the information was not valid anymore. Without checking, their reports would be insufficient and inappropriate.

According to the research, some students indicated that the information collected by ChatGPT was as open as possible; it was not possible to identify the exact necessity of which information was valid for their assignment.

With respect to critical thinking and problem-solving, findings were mixed. Most participants reported that ChatGPT had minimal influence on their critical thinking. But still there were some examples where a student declared that he was dependent on ChatGPT too often, and after several times he discovered that each of his decisions was checked, accepted or rejected by ChatGPT. He was not able to make his own decision independently. Another student has revealed that she was using ChatGPT too often, even in her private life and at last she was not able to make any decision independently. These all experiences shared by students have shown us, that even such helpful tool can be dangerous and have another dark side.

ChatGPT is a great tool which gives higher opportunities to its users, but there is still a real life, where tutors can identify the real knowledge of students. That means that even after using ChatGPT, the accomplishment level of the assignment is high, and the tutor can evaluate the specific student for lower grades. AI tools can't be the real measurement of the knowledge of students.

When asked how ChatGPT could be used most effectively in business administration programs, participants emphasised that lecturers should instruct students on how to use AI ethically—specifically in ways that minimise negative effects while still enabling efficient access to useful information.

Overall, students evaluated their experiences positively. Some students have reported that their behaviour of using ChatGPT to accomplish their homework was unethical and cannot be assessed as a good student attitude to the learning process. This is a good sign that students who are aware of learning processes can evaluate using Chatbot as a bad sign and low performance. Another student remarked that their life had become significantly easier since the introduction of ChatGPT, noting that they used it not only in business administration but also across various other areas, and were highly satisfied with the tool.

In summary, the findings indicate that the use of AI assistants in business administration programs is widespread. Students believe that ChatGPT provides substantial academic support, while ethical misuse is viewed as contingent on individual students' intentions and willingness to accept responsibility.

Conclusion

The results of this research revealed comprehensively the level of the business administration students' usage of ChatGPT throughout the learning process. The research has revealed the benefits, challenges and other ethical issues related to ChatGpt. The survey discovered that the most number of the students using ChatGPT throughout their learning process, but the influence is different according to the specific and form

of using the Chatbot. Students are relying on the AI tool too much and very often they are not checking the information. For many learners, ChatGPT serves as an accessible and time-saving support mechanism that simplifies information search and helps them concentrate more effectively on understanding and internalising study materials.

Based on the summary of the research findings, the following answers to the research questions were identified:

How do students use ChatGPT in the learning process within business administration programs?

Students enrolled in business administration programs make active use of ChatGPT throughout their learning process. They rely on the AI assistant to search for new information related to topics of interest. Students also request ChatGPT to help complete assignments and even to identify solutions for situational case problems.

What benefits do students perceive in the use of ChatGPT?

The primary benefits students identify include ChatGPT's accessibility, ease of use, and the time-saving opportunities it provides. The time that would otherwise be spent searching for information can instead be devoted to studying and assimilating that information more thoroughly.

What challenges do students face when using ChatGPT?

The main challenge concerns the inaccuracy of information that ChatGPT may provide in certain instances. Additionally, there are risks associated with plagiarism, as well as the dangers of excessive reliance on ChatGPT during the learning process. Overuse may negatively affect the development of students' critical thinking and problem-solving skills.

What are students' views on the ethical aspects of using ChatGPT?

The study revealed that ChatGPT can still be used in the learning process as a means of avoiding responsibility, which is highly unethical. Nonetheless, students sometimes adopt such practices based on personal reasoning or motivations.

What do students think about the influence of ChatGPT on the acquisition of business skills?

The research has shown us that students think that ChatGPT has the potential to influence students in the real-life learning process, because in reality, students are using ChatGPT without checking the information. So they can't be sure to get appropriate information from the Chatbot. Relying on the ChatGPT will not help students to develop critical thinking and problem solving skills.

Recommendations derived from the study include the following:

Lecturers should clearly explain the unethical and negative aspects associated with the use of ChatGPT.

Lecturers should ensure that students are taught how to use ChatGPT ethically within business administration courses.

High pressure of academic work can be a stimulus to use ChatGPT in unethical ways. A large amount of work and home assignments can be a reason to start such behaviour.

Regarding the research, many students consider that the ethical issue of using ChatGPT is the key. Many students can perceive their responsibilities for using Chatbot throughout learning process. The main issue is that, to have a battles against ChatGPT would not be as efficient as being aware the unethical issues of using ChatGPT by the students.

Regarding business skills development, students agreed that ChatGPT holds substantial potential to enhance their learning—provided that it is used appropriately and in moderation. Students emphasise that ChatGPT is a crucial part of their learning process, but still it can't replace the academic learning process and live interaction between lecturers and students. There is some evidence that if students excessively rely on AI tools, they can experience weakened decision-making and problem-solving skills.

The study concludes that, to enhance the effective use of AI assistants, it is essential to provide students with accurate information about these tools. Students must be aware of the potential risks and negative consequences, after which they can make informed decisions regarding the extent and manner in which they should use ChatGPT during their studies in business administration programs.

References

1. A. Austat, S. Suherlan and H. Azzakiyyah, "Is ChatGPT Dangerous for Lecturer Profession? An In-depth Analysis," vol. 5, no. 2, 2023.

2. A. Basir, E. Puspitasar, C. Aristarini, P. Sulastri and A. Austat, "Ethical Use of ChatGPT in the Context of Leadership and Strategic Decisions," vol. 12, no. 1, 2023.

3. A. Subagja, A. Austat, A. Sari, WanofqM and S. Suherlan, "Improving Customer Service Quality in MSMEs through the Use of ChatGPT," vol. 12, no. 2, 2023.

4. N. Rane, A. Achar and S. Choudhary, "Enhancing customer loyalty through quality of service: Effective strategies to improve customer satisfaction, experience, relationship, and engagement," vol. 5, no. 5, 2023.

5. M. Javaid, A. Haleem and R. Singh, "ChatGPT for healthcare services: An emerging stage for an innovative perspective.," vol. 3, no. 1, 2023.

6. I. Gremyr, A. Birch-Jensen, M. Kumar and N. Lofbeg, "Quality functions' use of customer feedback as activation triggers for absorptive capacity and value co-creation," vol. 42, no. 13, 2022.

7. S. Omenazu, "Strategic Management, Decision Making And Organizational Performance: Case Study Of Construction Industry Malaysia," vol. 6, no. 3, 2022.

8. M. Harahap, A. Austat, A. Rachman, Y. Riady and H. Azzaakiyyah, "Overview of ChatGPT Technology and its Potential in Improving Tourism Information Services.," vol. 12, no. 2, 2023.

9. S. Ortiz, "What is ChatGPT" How the world's most popular AI chatbot can benefit you," 2024. [Online]. Available: https://www.zdnet.com/article/what-is-chatgpt-how-the-worlds-most-popular-ai-chatbot-can-benefit-you/. [Accessed 2 12 2025].

10. J. Dempere, K. Modugu, H. Allam and L. Ramasamy, "www.Fronteirsin.org," 2023. [Online].

Available: https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2023.1206936/full. [Accessed 3 12 2025].

11. Y. Huang, J. Wei Chang, C. Yang, O. Hiroaki, A. Shun ting Li, R. Yen and S. Yang, "Personalised intervention based on the early prediction of at risk students to improve their learning performance," Journal Educational Technology and Society, vol. 26, no. 4, 2023.

12. N. Abdallah, R. Katmah, K. Khalaf and H. Jelinek, "Systematic review of ChatGPT in higher education: Navigating impact on learning, wellbeing, and collaboration," Social Sciences and Humanities open, 2025.

13. H. Ahmed and S. Abu, "Drivers and Consequences of ChatGPT Use in Higher Education: Key Stakeholder Perspectives," Journal Psychology and Education, vol. 13, no. 11, 2023.

14. M. Abbas, A. Jam and T. Khan, "Is it harmful or helpful? Examining the causes and consequences of generative AI usage among university students," International Journal of education, vol. 21, no. 10.

15. S. Ortiz-Bonnin and J. Blahopoulou, "Chat or cheat? Academic dishonesty, risk perceptions, and ChatGPT usage in higher education students," Social psychology of Education, vol. 28, 2025.

16. N. Nasr, A. Tu ch, J. Werner, T. Bauer, C. Yen and L. Sujo-Montes, "Exploring the Impact of Generative AI ChatGPT on Critical Thinking in Higher Education: Passive AI-Directed Use or Human–AI Supported Collaboration?," Education Sciences, 2025.

No 179 (2025)

Sciences of Europe
(Praha, Czech Republic)

ISSN 3162-2364
The journal is registered and published in Czech Republic.
Articles in all spheres of sciences are published in the journal.

Journal is published in Czech, English, Polish, Russian, Chinese, German and French, Ukrainian.
Articles are accepted each month.
Frequency: 24 issues per year.
Format - A4
All articles are reviewed
Free access to the electronic version of journal

«Sciences of Europe» -
Editorial office: Křižíkova 384/101 Karlín, 186 00 Praha

E-mail: info@european-science.org
Web: www.european-science.org