

Recycling, upcycling and downcycling in aspect environmental safety

Mateusz Czekafa 

2nd Military Economy Branch, Wrocław, Poland,

e-mail: maticzeki1998@gmail.com

INFORMATION

Article history:

Submitted: 14 February 2023

Accepted: 18 August 2023

Published: 15 September 2023

ABSTRACT

A problem concerning a topic discussed in the public domain for many years. Presentation of its advantages and possibilities that create appropriate attributes for its publications. Despite the fact that there are people with whom they have a problem understanding this concept. It is a word heard but not fully understood by society. The cited document discusses the concept and scope of application, as well as its application and the impact of safety under the concept of ecological safety on its operation.

KEYWORDS

recycling, ecology, ecological safety, waste, circular economy



© 2023 by Author(s). This is an open access article under the Creative Commons Attribution International License (CC BY). <http://creativecommons.org/licenses/by/4.0/>

Introduction

In recent years, in Poland and member states of the European Union, the situation related to the multifaceted use of ecology in work and everyday life has been mentioned increasingly often in the field of security. The current trend towards pro-ecological operations is developing at a rapid pace and is related to numerous approaches to professional and existential spheres of interest. The protection of the world we live in is the task for which not only public authorities, but also of every human being is responsible. And all forms of using already consumed products in a new way are expected by society. In addition, the industrial environment surrounding us also minimizes the negative impact on the surrounding environment, which means that attention

should be paid to how important taking care of the environment and reusing what we have in the surrounding world becomes in everyday existence and security. The research problem of the article is the incomplete understanding and use of recycling in the context of ensuring ecological security, and the objective that has been set it is to present the possibility of using recycling and its variants in the context of security. The main research technique used in the article is the review of the literature.

1. Ecological aspect of security

One of the fundamental issues with regard to the contemporary environmental policy is a combination of socio-economic development with the synchronous protection of the natural environment around us. At the turn of the century, we witnessed a huge pace of changes taking place, which was caused, among others, by significant technological development, as well as pollution and poisoning of ecosystems and the emergence of ecologically conditioned hazards. This is why the common ground, which is security, began to gain attention [1].

Security has many definitions. According to the *Dictionary of National Security Terms*: “security is a state that gives a sense of certainty and a guarantee of its preservation and a chance for improvement” [2, p. 13]. However, usually the term security is used to describe both a state (i.e., the perception of the safety of a specific subject) and a process (which becomes a guarantee of the feeling of the subject’s security). Nevertheless, the second position which formulates the obvious natural and active nature of the vision of security is deemed to be much more rational [3]. The question of security has become an existential dilemma due to its great importance for the form of existence itself and a competent way of persisting in in the functioning world. The necessity to give and feel security is a key sphere in human existence. Therefore, if the lack of ecological security is also naturally perceptible, its functioning must be taken into account too. This aspect will be described in the following article [4].

Environmental security corresponds to the problems of environmental degradation having a direct impact on the deteriorating health of the human population. Its objective is to achieve the best possible state of the environment while ensuring the smooth development of civilisation. Therefore, it is responsible for developing certain existential conditions which will not threaten nature [5; 6]. There are two main directions of activity in environmental security:

- Positive thinking, covering pre-emptive measures, as well as preventive and forward-looking thinking about stabilising the environment. These tasks focus on reducing the occurrence of threats;
- Negative, aiming at the elimination of already existing negative effects of natural changes.

Furthermore, environmental security, as an interconnected system of executive institutions with identical, well-defined objectives should focus on the development of effective rules of conduct both in times of peace, crisis or war [7].

2. Recycling

Proper management of material resources aids in the fight against excessive waste production and represents a huge challenge for the national industrial economy [8]. The key component here is to strive to close the raw materials cycle by incorporating used components and parts from products unsuitable for further use [9]. This process, based on the creation of mechanisms and the organisation of the secondary flow of materials, is called recycling [10]. Its main principle is to maximise the utilisation of resources with a minimum amount of processing, which may be composed of sorting, grinding, granulating, hydrolysis or glycolysis [11].

Waste recovery in the form of using it to generate energy through incineration is not qualified as recycling. This aspect, together with the reduction of amount of landfilled waste and the reduction of greenhouse gases produced, makes recycling one of the pillars of ensuring environmental security.

3. A brief history of recycling

The first official state document to address the issue of recycling was an edict issued by King Stanisław August Poniatowski in 1777, which ordered the separation of waste in the form of “rags, paper shavings, parchment edgings, leather trimmings, sheep’s feet and other kinds of stuff suitable for producing glue under pain of punishment”. This information was published in Kwidzyń in two languages – Polish and German [12, p. 8]. The oldest manual waste sorting plant was built at the turn of the 19th and 20th centuries in New York. Serving 116,000 inhabitants, it was able to recover up to 37% of recyclables, and a few years later a mechanical version based on drum screens and sorting

belts was built in Munich, Germany [13]. The next breakthrough in recycling was the launch of a municipal waste incineration plant in Poznań in 1927, shown in Figure 1.



Fig. 1. Formerly and today. Waste incineration plant on Szląg

Source: [14].

The several-stage, mechanical and manual segregation of objects allowed, among other things, for recovering metal parts that were sold to steelworks, while the selectors captured textiles and glass to get rid of non-flammable components. The end product of the incineration plant was slag, which was used to produce asphalt pace [15].

After the Second World War, District Enterprises for Recyclable Material Management were established in Poland to buy back scrap metal, waste paper and glass bottles. As they offered commodities that were very scarce for the communist period, such as pots and toilet paper, these buyback facilities functioned very efficiently, and some of them, taken over by the private sector, are still in operation today.

4. Legal aspect of recycling in Poland and the European Union

Legal considerations on the concept of recycling in the European Community date back to the early 1970s, and the first official regulation in the form of the Waste Directive, bearing number 75/442/EEC, was adopted on 15 July 1975. The primary objective of this document was to minimise the effect of unrecorded waste shipment within the various countries of the European Community. In addition, the principles of hazardous waste management underwent preliminary regulation [16]. In Poland, the topic of the legal regulation of recycling was not formally addressed until the beginning of the

21st century, mainly due to the aspirations of joining the EU and the consequent need to adapt the national regulations to European standards. The current legal status of recycling in Poland and the European Union is based on two directives and acts of law harmonised with them:

- The 2008 Waste Framework Directive, which defines the optimal order in which waste should be dealt with according to desirability and introduces compulsory charges for polluters [17];
- The 1994 Directive on Packaging and Packaging Waste – defining measures to reduce the negative impact of packaging on the environment as quickly as possible and to systematise recycling-oriented activities [18];
- The Waste Act of 14 December 2012 [19], defining resources intended to protect the environment and human life by minimising waste and its harmful effects, with the ultimate aim of achieving a circular economy. This act repealed the previous act of the same name, which was the first attempt to implement the European Community regulations in the field of, in particular, environmental protection, waste, packaging or used electrical and electronic equipment.
- The Act of 13 June 2013 on the management of packaging and packaging waste [20], which defines, in particular, the rules for the handling of packaging, the operations of organisations conducting its recovery and production requirements. It is also the second ever law of this name and implements the European Parliament’s provisions on packaging and the framework for Community measures contributing to the sustainable use of pesticides. Apart from the acts of law and directly related executive acts, the National Waste Management Plan 2022 adopted by Resolution No. 88 of the Council of Ministers of 1 July 2016 and the Draft Resolution of the Council of Ministers on the National Waste Management Plan 2028 are also crucial. These documents contain information with regard to waste management in the scope of, among others:
 - Analysis of the current state;
 - Forecast of changes;
 - Goals;
 - Courses of actions;
 - Environmental impact assessments.

The national waste management plan is a cyclical project adopted every 6 years.

5. Benefits of recycling

Recycling is a process which is becoming increasingly important and, along with the transition of the energy sector transition towards low-carbon energy sources, is the most important challenge in improving safety and environmental protection in peri-urban areas. Due to its comprehensive advantages and possible tax credits covering many aspects, it is not highly burdensome for households nor for manufacturing companies. The most important benefits derived from recycling include:

- Protection of natural resources – the reprocessing and reuse of limited resources means that valuable minerals which are difficult to extract, and process will be possible to extract for a longer period without having to look for alternative materials that may not meet requirements and inhibit technical and technological development;
- Environmental protection – overexploitation of natural resources causes significant degradation of the landscape and disturbance of the ecosystem, and large quantities of waste cause, among other things, ingestion of hazardous waste by animals;
- Financial savings – processing a portion of the waste consumes far less energy than the original manufacturing (production), and reusing items results in generating lower rubbish disposal fees;
- Health protection – less food and drink packaging results in a lower risk of the occurrence of rats and other rodents transmitting various diseases [21].

6. Recycling as a component of the 3Rs principle and the circular economy

The most important long-term goal of the European Union is to strive for sustainable development, in which a dynamic process of economic growth will take place at the lowest possible cost to the environment and the principles of social justice [22]. The achievement of these goals is possible owing to a smooth transition from a linear to a circular economy. It is characterised by a focus on the long-term lifecycle of the product and the most economical management of natural resources, which directly affects the minimalization of the amount of generated waste [23]. Materials are used several times in the production cycle and, depending on their qualitative status, they perform various functions in the final product.



Fig. 2. Product lifecycle

Source: [24].

Referring to Figure 2, which presents the cycle of circular economy, the most important stage in the life of a product developed with a focus on long service life is design. In this phase the assumptions of the easiest possible access to the elements most susceptible to failure or malfunction must be met, as well as the uncomplicated possibility of separating and recovering the most valuable structural elements. Furthermore, the product lifecycle consists of consecutive stages:

- Production – manufacturing the product and its constituent process of converting used materials into a finished whole;
- Distribution – in such a way that the largest possible percentage of products find an owner;
- Consumption – maximised use of the item by the user, including repair processes;
- Collection – recovery of materials from appropriate waste containers;
- Recycling – preparation for the reuse of raw materials in the production process.

The waste hierarchy is based on 3 of the above processes – consumption, collection and recycling, which is referred to in the 3R principle (Reduce, Reuse, Recycle) focused on the consumer's approach to the issue of circular economy (CEc). The customer's self-awareness regarding the choice of products which are easier to repair, created with the significant use of recycled

elements, has a significant impact on the direction of manufacturers' development. In free market economies, the fashion for Eco items is one of the biggest driving forces of pro-recycling changes.

Reduce/Avoid (excessive consumption) nowadays, due to the availability and proximity of shops, we do not plan long-term purchases, however, by buying the same products less often but in larger quantities we are able to reduce the amount of packaging and thus generate less waste. A conscious approach to this topic also allows for saving money.

Reuse – this rule applies to the reuse of items considered to be both reusable and disposable. All kinds of glass containers or plastic bags can be easily used for a long time and the only limitation in changing the way of using an item is often human imagination.

Recycle – if the above possibilities are impossible to carry out, sort the waste into appropriate containers, sometimes separating individual elements

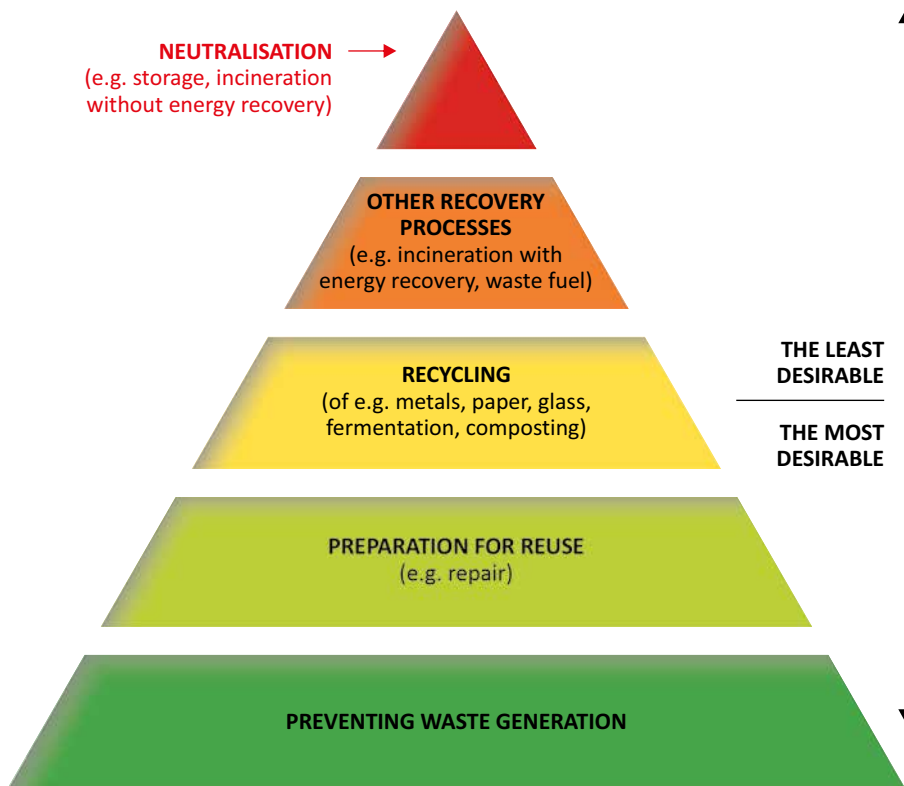


Fig. 3. Waste management hierarchy

Source: [26].

of a complete item. Containers for waste segregation are currently widely used throughout the country [25].

From the perspective of EU and national regulations, the waste hierarchy includes two additional (in addition to the 3Rs principle – to be read as Reduce, Reuse, Recycle), less desirable ways of dealing with waste presented in Figure 3, i.e., other recovery and disposal processes.

Other recovery processes – a form of recovering waste which cannot be reused but which has energy value allowing the recovery of some of the energy during incineration.

Neutralisation – applies mainly to hazardous materials and consists in safe long-term storage or incineration. However, this division is not very detailed, a separate pyramid can be made from each block illustrated in Figure 2, but in accordance with the topic of the article, the focus was placed on the issue of recycling.

7. Types of recycling

Recycling covers all operations and activities the main goal of which is to create a new product through efficient waste management. Its scope covers, among others:

- Raw material recycling – i.e. chemical recycling which obtains raw materials through chemical processes, e.g. transforming plastic packagings into brand-new plastic products.
- Thermal recycling – referred to as energy recycling, because the most important element is the energy generated as a result of waste incineration. It is a form of reusing plastic as, among others, a fuel or raw materials needed in other thermal and chemical cycles.
- Material recycling – its task is the mechanical processing and the method of re-acquiring raw materials from waste products in order to produce a new element from them, e.g. the formation of granulate from worn out vehicle tires.
- Organic recycling – or composting, biodegradable waste is separated by microorganisms as a result of which e.g. compost or methane is produced [22].
- Despite the widespread use of recycling, two related terms have been distinguished in recent years: Upcycling and Downcycling.

Upcycling as a form of recycling that allows for not only reusing a given item but for doing it in such a way that increases its value [27]. The most

important factors are the aesthetic values but also the usability of such products. The global Eco trend makes such measures highly desirable and their role is growing. The art industry promotes “trash art”, i.e. modifying unfashionable objects into timeless, eye-catching ones. Times of recession and economic crisis additionally increase the role of minimising consumption and make the human imagination the only limitation of Upcycling [28]. Promotion of this type of reuse most often occurs on the Internet, because the sale of creatively processed objects is often conducted by small start-ups. Despite the market dispersion, the popularisation of pro-eco education occurs also in social media. Short instructional videos demonstrate the possibilities of reusing products in unconventional ways and are eagerly watched by users. The use of Upcycling is pursued in, among others, art as a unique work of art. Its use can also be found in garden furniture, such as stairs, flowerpots. Household furniture items made of pallets, such as poufs, tables and sofas, also create unique impression.

Downcycling is the reuse of waste, but with a reduced value compared to the original application. The vast majority of recycled items are used in less demanding products, permitting lower quality (contamination) of raw materials. The most popular household example of Downcycling is a shopping bag serving as a garbage bag. It is implemented on a still larger scale in the building industry reusing automotive steel and in the Armed Forces where cotton fabric serves as cleaning cloth. Each of the described methods has a positive impact on the natural environment, limits the exploitation of natural resources and reduces the amount of garbage and waste.

Conclusions

The concept of recycling can also be used to describe the reduction of energy consumption, protection of the environment, as well as natural goods along with the minimisation of the exploitation of non-renewable raw materials, which, unfortunately, are becoming scarce their resources are rapidly shrinking. The majority of the municipal waste is reused, and, owing to this, valuable raw materials can be recovered. In the process of their conversion, both natural raw materials are saved and the dangerous impact on the surrounding environment is reduced. In addition, the acquisition of secondary raw materials through recycling is usually much cheaper than the re-extraction of new components. The popularity of recycling is constantly on the rise. The economic advantages of its implementation and also the continuous technological

development worldwide, make the possibilities of recycling secondary raw materials more innovative as well. In order to create such a properly and functionally working process, legislative, educational and systemic changes are also needed. Conscious transition to circular economy is also becoming noticeable, which contributes to the creation of new jobs, education of the society, curbing the number of landfills, improvement of the visual values of the landscape, increase in the number of tourists or improvement of air and water quality. Finally, it can be concluded that in a future perspective recycling is still open to new concepts and ideas. Within its scope there is still a lot of room for innovation and improvement, so that the process itself proceeds well and the obtained raw materials can become a substitute while extending their service life.

References

1. Zapolska K. *Bezpieczeństwo ekologiczne jako element bezpieczeństwa narodowego RP*. Digitized and made available as part of the project entitled Expansion of open scientific resources of the Repository of the University of Białystok, co-financed from the “Social Responsibility of Science” program of the Minister of Education and Science on the basis of an agreement SONB/SP/512497/2021.
2. Łepkowski W (ed.). *Słownik terminów z zakresu bezpieczeństwa narodowego*. Warszawa: Wydawnictwo AON; 2002.
3. Konstańczak S. *Postęp cywilizacyjny a bezpieczeństwo ekologiczne (Civilization progress and ecological security)*. JEcolHealth. 2010;14(6):272-75.
4. Rakoczy B. *Wybrane problemy prawa leśnego*. Warszawa: Wolters Kluwer Polska; 2011.
5. Bucińska J. *Administracja publiczna – człowiek a ochrona środowiska: Zagadnienia społeczno-prawne*. Warszawa: Wolters Kluwer Polska; 2011.
6. Śladkowski S. *Bezpieczeństwo ekologiczne RP*. Warszawa: Wydawnictwo AON; 2004.
7. Pietrzyk-Sokulska E. *Recykling jako potencjalne źródło pozyskiwania surowców mineralnych z wybranych grup odpadów*. Zeszyty Naukowe Instytutu Gospodarki Surowcami Mineralnymi i Energią PAN. 2016;92:141-61.
8. Komunikat Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego i Komitetu Regionów, KOM (2014) 398, Ku gospodarce o obiegu zamkniętym: program „zero odpadów” dla Europy, Bruksela, 02.07.2014 r.
9. Górniak-Bodziany A, Bodziany M. *Ekologistyka – wyzwanie czy warunek konieczny funkcjonowania SZRP*. Zeszyty Naukowe WSOWL. 2008;1(147)243-53.
10. Duda I (ed.). *Słownik pojęć towaroznawczych*. Kraków: Wydawnictwo Uczelniane. Akademia Ekonomiczna w Krakowie; 1994.
11. Janka W. *Historia gospodarki odpadami*, [online]. Available at: http://www.forum-dyrektorow.pl/dokumenty/ArtPdfFiles/C20_Historia_gospodarki_odpadami.pdf [Accessed: 19 January 2023].

12. Hryb W, Ceglarski K. *Odpady komunalne w aspekcie gospodarki o obiegu zamkniętym*. Gliwice: Wydawnictwo Politechniki Śląskiej; 2021.
13. Niemiec A. *Zagrożenia bezpieczeństwa pracy pracowników zatrudnionych na komunalnych składowiskach odpadów*. Zeszyty Naukowe Politechniki Poznańskiej. 2014;62: 97-114.
14. *Spalarnia śmieci na Szeląggu była jedyną jaką wybudowano w Polsce w okresie II Rzeczypospolitej*, [online]. Available at: <https://www.poznan.pl/mim/s8a/czy-wiesz-ze,doc,576/-,2186.html> [Accessed: 19 January 2023].
15. Kosieradzka-Federczyk A. *Priorytety Unii Europejskiej w gospodarowaniu odpadami*. Zeszyty Naukowe Wydziału Informatycznych Technik Zarządzania Wyższej Szkoły Informatyki Stosowanej i Zarządzania w Warszawie. 2013;1:47-63.
16. Dorobek S, Bursztyński A. *Recykling surowców w Polsce – ewolucja i rozwiązania logistyczne*. Logistyka. 2014;6:526-41.
17. Zarębska J. *Gospodarka o obiegu zamkniętym drogą do zrównoważonego rozwoju*. Systemy Wspomagania w Inżynierii Produkcji. 2017;6:286-95.
18. Stahel W, Reday G. *Report The Potential for Substituting Manpower for Energy*. Geneva: Geneva Research Centre; 1977.
19. *Ustawa z dnia 14 grudnia 2012 r. o odpadach*, [online]. Available at: <https://www.global-regulation.com/translation/poland/8302260/act-of-14-december-2012-on-waste.html> [Accessed: 19 January 2023].
20. *Zasada 3R*, [online]. Available at: <https://włączoszczędzanie.pl/zasada-3r-reduce-re-use-recycle> [Accessed: 18 January 2023].
21. *Recykling termiczny tworzyw sztucznych*, [online]. Available at: <http://www.eldezet.pl/recykling-termiczny-tworzyw-sztucznych> [Accessed: 20 January 2023].
22. *Co to jest recykling, na czym polega, jakie są jego rodzaje i etapy?*, [online]. Available at: <https://www.products.pcc.eu/pl/blog/co-to-jest-recykling-na-czym-polega-jakie-sa-jego-rodzaje-i-etapy> [Accessed: 21 January 2023].
23. Izdebska K. *Lepsze życie śmieci*. Kultura Popularna. 2017;2:32-43.
24. *Gospodarka obiegu zamkniętego. Czym jest i skąd się wywodzi? – webinarium Biura Regionalnego PARP w Poznaniu*, [online]. PARP. PFR Group. 20 May 2022. Available at: <https://en.parp.gov.pl/component/content/article/80901:gospodarka-obiegu-zamknietego-czym-jest-i-skad-sie-wywodzi-webinarium-biura-regionalnego-parp-w-poznaniu> [Accessed: 21 January 2023].
25. Czuba M. *Upcykling jako element zielonego marketingu*. Marketing i Rynek. 2017;9: 16-20.
26. Rogala B. *Rozszerzona odpowiedzialność producenta, czyli kto powinien płacić za śmieci w Polsce*, [online]. 300Gospodarka. 28 August 2020. Available at: <https://300gospodarka.pl/explainer/rozszerzona-odpowiedzialnosc-producenta-co-to> [Accessed: 21 January 2023].
27. Wąsowicz J. *Upcykling, co to dokładnie jest? Czym różni się od recyklingu?*, [online]. Available at: <https://home.morele.net/poradniki/upcykling-co-to-dokladnie-jest-czym-rozni-sie-od-recyklingu/> [Accessed: 19 January 2023].

28. *Upcykling w Polsce – wszystko, co musisz wiedzieć*, [online]. 26 February 2021. Available at: <https://trashki.pl/blogs/co-u-nas-slychac/upcykling-co-musisz-wiedziec> [Accessed: 19 January 2023].

Recycling, upcycling i downcycling w aspekcie bezpieczeństwa ekologicznego

STRESZCZENIE

Problem recyklingu to temat poruszany w zakresie publicznym od wielu lat. Przedstawianie jego zalet i możliwości, które stwarza, jest tematem wielu zarówno naukowych, jak popularnych publikacji. Jednakże nieustannie pojawiają się wątpliwości związane przede wszystkim ze zdefiniowaniem tego pojęcia. Jest to słowo szeroko używane, ale nie do końca rozumiane przez społeczeństwo. W poniższym artykule zostało omówione pojęcie i zakres recyklingu, a także jego zastosowanie oraz wpływ bezpieczeństwa pod kątem bezpieczeństwa ekologicznego na jego funkcjonowanie.

SŁOWA KLUCZOWE

recykling, ekologia, bezpieczeństwo ekologiczne, odpady, gospodarka o obiegu zamkniętym

Biographical note

Mateusz Czekala – Second Lieutenant MSc Eng, Head of the Uniformed Service of the 2nd Military Economy Branch in Wrocław, graduate of the Military University of Technology, interests: material logistics, safety of critical infrastructure, history of the art of war, modernisation of the Polish Armed Forces. Scientific achievements: 2 scientific articles.

ORCID

Mateusz Czekala  <https://orcid.org/0000-0001-8337-9762>

Acknowledgement

No acknowledgement and potential funding was reported by the author.

Conflict of interests

The author declared no conflict of interests.

Author contributions

The author contributed to the interpretation of results and writing of the paper. The author read and approved the final manuscript.

Ethical statement

The research complies with all national and international ethical requirements.