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REVIEW PAPER

Intoxication with new drugs – an ongoing challenge for public health and education*

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Abstract

Use of chemicals classified collectively as the so-called new drugs that include narcotic replacement drugs and new psychoactive substances constitutes a phenomenon adversely affecting human health. These drugs may contain new, often undescribed chemical compounds, whose health and social effects are difficult to predict fully. Analyses of the chemical composition of new drugs have confirmed that they contain compounds with psychoactive effects; however, their content and proportions of the particular components vary. Use of addictive substances has become widespread due to the currently prevailing fashion as well as their entertaining nature. They affect the physical and psychosocial health of individuals, causing serious consequences for them, their families and the society at both social and economic levels. Therefore, prevention of the use of new drugs aims at promoting a healthy lifestyle with reference to mental and physical health. As new psychoactive substances appear on the market, recommendations are being made on an ongoing basis covering new substances, for example ones identified in Poland, that have the potential to affect human health or life. It is difficult to list the most dangerous and addictive substances. Selected substances are discussed in this paper. Prevention of the problems associated with use of the new drugs consists mainly in sharing knowledge about effects of these substances on the human body, dispelling myths about their supposed harmlessness as well as appealing to the value system of the recipients, also in the context of building a healthy and mature personality.

Keywords: narcotic replacement drugs, new psychoactive substances, human health, public health, education

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INTRODUCTION

Reports of intoxication incidents due to the use of illegal stimulants appear in the media almost every day. These range from articles in various magazines and journals, through reports on TV news programs and radio, to documentaries. All of them raise the topic of drugs, including new drugs, such as narcotic replacement drugs (NRD) and new psychoactive substances (NPS). In general, narcotic replacement drugs and new psychoactive substances have come to be known as new drugs. They pose a significant problem for public health as well as for a wide range of healthcare professionals, Emergency Medical Teams (EMT), educators, psychologists and legislators in many countries. This is mainly related to a very rapid increase in the number of substances and their high chemical similarity (Sadło et al. 2021).

Substances with psychoactive effects (smart drugs, designer drugs) have accompanied mankind since the dawn of humanity. It is estimated that use of agents (plants and decoctions) with psychoactive effects for cult purposes may have taken place around since at least 9.000 BC. In the Neolithic period, a fly agaric decoction that demonstrated strong hallucinogenic effects was used. As reported in the literature, man has been cultivating and using poppy seeds in the Mediterranean region since about 6.000 BC, opium since at least 3.000 BC, while marijuana has been smoked since 500 BC. Undoubtedly, they were applied for medicinal purposes to put people to sleep, to calm agitated individuals, crying children, to anaesthetize during surgical procedures as well as for all types of pain and ailments. Plants with narcotic effects were used to poison arrows and spears, which could lead to death by suffocation or paralysis of the heart muscle when used in strong concentrations of the toxic substance. There are reports describing the use of highly concentrated psychoactive substances for euthanasia, surreptitious poisoning, or for numbing before being burned alive (Serrano 2018, Chmielewski et al. 2020, Fatur, Kreft 2020, Rakesh et al. 2022). However, these substances were used by humans at that time without complete awareness of their negative health consequences

The problem of chemical addiction as one of the largest social problems of the modern world was observed in the second half of the 20th century. It coincided with the actions initiated by President Richard Milhous Nixon in the United States called the War on Drugs. As a result, worldwide delegalisation of the substances classified as “classic drugs” began. In order to avoid legal consequences and to circumvent the law, a market for creation and production of new drugs (NRD/NPS) was established, which, unlike those already known to medicine, proved unpredictable in their health and social effects (Chmielewski et al. 2020).

Addiction constitutes an intense desire of an individual to possess what his or her mind desires. Addiction is a complex biological and psychological event that specific social factors contribute to. More specifically, with regard

to addiction to psychoactive substances, it is believed that this is a mental or physical condition characterized by the need to take substances continuously or periodically in order to experience the effects of the substance or to avoid the discomfort caused by withdrawal (Pickard 2021). Health and social consequences of the use of the new drugs (NRD/NPS) is becoming an increasingly important public health problem. The use of the new drugs (NRD/NPS) may not only cause various negative health consequences, but it can also be a cause of death. As a result, it is so important to raise public awareness through extensive educational activities from the beginning of the educational process aimed at spreading knowledge about their negative effects and influence on human health (Motyka et al. 2017).

Currently, the Internet has become a place for dissemination of the new drugs (NRD/NPS) on an unprecedented scale. This is because it provides ideal conditions for global trade. Users can directly contact the seller, receive regular notices of new products by e-mail or text messages and share them with others. People interested in taking new drugs (NRD/NPS) easily share their knowledge and the network allows access to various forms of information transfer. New drugs (NRD/NPS) and information on their effects are thus available to almost everyone, and trafficking occurs mainly through numerous illegal websites (Corazza et al. 2012). As data from Statistics Poland (GUS) show, disorders caused by the use of psychoactive drugs in Poland constituted in 2021 the third most numerous distinguished group of diseases under psychiatric treatment, namely 2.9% of the total number of patients (i.e. 53.6 thousand people, 13.6% more than in 2020 and 16.9% more than in 2019). These include addiction and abstinence syndromes, acute poisoning and harmful use, psychotic disorders. For this group of diseases, the rate of patients per 100.000 people from the Polish population in 2012 was 141, which was higher by 18 people than in 2020 and by 22 people in 2019. The highest prevalence rates for these diseases were recorded in the following provinces (voivodeships): łódzkie (234 patients per population of 100.000 people) and mazowieckie (233), while the lowest ones were noted in the following provinces: warmińsko-mazurskie (84) and podkarpackie (47) (CSO 2022). In 2023, the Monitoring Information System for Narcotic Replacement Drugs and New Psychoactive Substances recorded 28 deaths after using substances with effects on the central nervous system (GUS 2023). The above data clearly indicate that efforts to counteract the distribution of the new drugs (NRD/NPS) require not only effective measures, but also the studies of this phenomenon. Despite widely promoted prevention programs, addiction is one of the largest current public health challenges. A coherent drug policy requires a rational combination of criminal interference with medical, therapeutic and preventive measures (Celińska-Chomiuk 2019). A holistic model of education, assuming the focus on the human being as a whole, is of great importance as well.

Every year, up to a few dozens of new drugs (NRD/NPS) appear on the market. There is a lack or very little literature data regarding their physico-

chemistry, pharmacology or toxicity. All this is means that poisonings with the above compounds are very difficult to identify and only a quick diagnosis gives a chance for the implementation of proper treatment. The dynamic development of the market for new drugs (NRD/NPS) requires toxicologists, chemists, analysts to update the library of data on new psychoactive substances on a constant basis.

The scale of intoxication incidents with new drugs (NRD/NPS) in Poland from 2015 to 2023 with division according to voivodeships is presented Table 1, while Table 2 shows fatal intoxication cases reported to the Monitoring Information System for Narcotic Replacement Drugs and New Psychoactive Substances in the period 2017-2023.

Table 1

Number of intoxication incidents involving NRD/NPS in the years 2015-2023 in Poland by voivodeships according to data of the Chief Sanitary Inspectorate (Chief Sanitary Inspectorate Report 2015-2016, 2017-2018, 2019, 2020, 2021, 2022, 2023)

Voivodeship	2015	2016	2017	2018	2019	2020	2021	2022	2023
Dolnośląskie	280	114	110	141	69	24	29	19	7
Kujawsko-pomorskie	480	208	250	262	129	73	23	19	16
Lubelskie	206	189	190	274	85	18	10	2	0
Lubuskie	412	143	63	157	105	23	1	15	36
Łódzkie	1499	1441	961	1094	625	250	187	47	28
Małopolskie	149	112	279	150	56	27	39	73	61
Mazowieckie	433	203	271	304	136	46	12	13	4
Opolskie	30	6	12	16	6	1	1	2	0
Podkarpackie	143	39	21	52	20	0	1	0	1
Podlaskie	142	48	54	52	24	12	5	5	3
Pomorskie	390	253	176	110	67	36	13	6	6
Śląskie	1854	987	1266	1114	595	171	45	16	56
Świętokrzyskie	132	142	106	63	16	6	7	2	5
Warmińsko-mazurskie	308	98	118	94	44	4	1	2	2
Wielkopolskie	712	324	395	290	139	79	109	72	27
Zachodniopomorskie	187	62	52	85	32	36	34	10	12
Total	7 357	4 369	4 324	4 258	2 148	806	517	303	264

Source; the authors

NEW DRUGS – NARCOTIC REPLACEMENT DRUGS AND NEW PSYCHOACTIVE SUBSTANCES

Use of NRD and NPS, i.e. substances classified together as the so-called new drugs, is one of the undesirable phenomena adversely affecting not only the health of individuals, but public health in the broadest sense. In Poland,

Table 2

Number of deaths involving NRD/NPS in the years 2017-2023 in Poland by voivodeships according to data of the Chief Sanitary Inspectorate (Chief Sanitary Inspectorate Report 2017-2018, 2019, 2020, 2021, 2022, 2023)

Voivodeship	2017	2018	2019	2020	2021	2022	2023
Dolnośląskie	0	16	13	0	1	1	1
Kujawsko-pomorskie	0	5	11	0	2	9	10
Lubelskie	2	12	2	1	1	0	0
Lubuskie	1	11	2	0	0	0	1
Łódzkie	1	16	7	2	0	3	0
Małopolskie	5	1	6	0	0	0	0
Mazowieckie	2	3	72	3	0	0	2
Opolskie	0	4	2	0	0	0	0
Podkarpackie	0	2	1	0	3	1	1
Podlaskie	0	3	1	0	0	0	0
Pomorskie	2	2	8	4	0	0	0
Śląskie	2	67	41	2	0	1	4
Świętokrzyskie	1	0	1	0	0	0	0
Warmińsko-mazurskie	0	1	5	1	1	0	8
Wielkopolskie	2	9	5	1	3	0	0
Zachodniopomorskie	1	10	7	0	0	0	1
Total	27	162	184	17	11	15	28

Source: the authors

the illegality of psychotropic substances and narcotics is provided for by the amended Act on Counteracting Drug Addiction of 29 July 2005 (the 2005 Act), according to which a substance or groups of substances of natural or synthetic origin in pure form or in the form of a preparation that has an effect on the central nervous system, other than a psychotropic substance and narcotic agent that poses health or social risks comparable to those caused by a psychotropic substance or narcotic agent, or that copies the effects of these substances, is considered to be a new drug (Chmielewski et al. 2020).

Among new drugs (NRD/NPS) available on the market, the following ones are mainly present: synthetic cannabinoids – a very numerous (about 150 substances), heterogeneous group of compounds; synthetic cathinones – nearly 200 compounds with a chemical structure structurally similar to a natural cathinone, amphetamine and similar to its action on the central nervous system; synthetic hallucinogens – equivalents of LSD, mainly substances from the NBOMe group, posing a huge threat to life and health due to their effects on the serotonin system; and synthetic opioids – a group of fentanyl derivatives and non-fentanyl substances, many times stronger

than classical opioids, with a significant risk of death as a result of their use (Zawilska, Wojcieszak 2013, Majchrzak et al. 2018, Chmielewski et al. 2020).

A range of types of psychoactive substances is immense although it is worth distinguishing the following groups: synthetic cathinones, synthetic cannabinoids, opioids, benzodiazepines, phenylethylamines or tryptamines.

CATHINONE

Cathinone is the main alkaloid found in young leaves and shoots of the qat (Catha edulis, khat), an evergreen plant naturally occurring in the northeastern part of Africa and the southwestern part of the Arabian Peninsula. Cathinone is a derivative of phenylethylamine and being structurally similar to catecholamines, it acts on the central nervous system and the sympathetic part of the vegetative system. Due to their structure and structural similarity to amphetamine, cathinone analogues are also called ß-keto-amphetamines (Wabe 2011, Valente et al. 2014).

SYNTHETIC CATHINONES

Synthetic cathinones belong to the group of organic stimulants. They demonstrate pharmacological effects similar to amphetamine or methamphetamines. Synthetic cathinones are structural analogues of cathinone, an alkaloid with psychostimulant effects that occurs in the qat (Catha edulis; khat), a traditionally popular plant remedy in African countries. The chemical structure of these compounds is largely similar to the structure of amphetamine and ecstasy. Synthetic cathinones exhibit stimulant and empathogenic effects (Kaizer-Będkowska, Kucia 2017, Wronikowska, Budzyńska 2020).

SYNTHETIC CANNABINOIDS

Synthetic derivatives of cannabinols are the most numerous group among the new psychoactive substances. They belong to the CB1 cannabinoid receptor agonists. Synthetic cannabinoids constitute a group of substances that includes both compounds naturally occurring in cannabis sativa, but also their synthetic analogues or metabolites. Synthetic cannabinoids are a group of compounds that have effects on cannabinoid receptors in the brain. Furthermore, it can be said that that they act similarly to Δ-9-tetrahydrocannabinol (THC), the main active ingredient in cannabis. Products containing synthetic cannabinoids are largely in the form of shredded green-coloured dried plant material and are intended to be smoked (Kaizer-Będkowska, Kucia 2017, Piechaczek et al. 2022).

OPIOIDS

Opioids are a group of substances with effects on opioid receptors. The term is used to describe natural (e.g. morphine), semi-synthetic (e.g. heroin) and synthetic (e.g. narcotic painkillers, including fentanyl) compounds with varied chemical structures. Opioids demonstrate an analgesic effect. Opioids include all substances with effects on opioid receptors: natural opiates, semi-synthetic poppy alkaloids, their synthetic derivatives and endogenous peptides. Natural opiates include: codeine, morphine, oripavine, pseudomorphine, tebaine. Semi-synthetic opioids include: oxycodone, hydromorphone, oxymorphone, hydrocodone and heroin. Synthetic opioids are chemically modified to replicate natural substances and they include tramadol, fentanyl, buprenorphine, tapentadol, methadone, levorphanol, propoxyphene, loperamide and pethidine (meperidine). According to users, opioids can be taken intravenously, inhaled, orally or as patches (Zaporowska-Stachowiak et al. 2019).

BENZODIAZEPINES

Benzodiazepines constitute a group of organic chemical compounds that display anti-anxiety, sedative, sleep-inducing or anticonvulsant effects. Chemically, benzodiazepines (alkyl, triazole, halogen, phenyl, etc.) are derivatives of benzo-1,4-diazepines. The basic chemical structure is formed by a combination of the benzene ring with a seven-membered heterocyclic diazepine ring. Benzodiazepines act by enhancing the action of the natural chemical in the brain, namely GABA (γ-aminobutyric acid), which is a neurotransmitter responsible for transmission of the information between brain cells (neurons) – Bienkowski (2016).

PHENYLETHYLAMINES

New synthetic phenylethylamines belong to the group of "entactogens" or 'empathogens', i.e. substances that induce increased empathy and a need to interact with the public in users. Phenylethylamines are a large group of organic chemicals, of which the best-known drugs in Europe are amphetamine, methamphetamine and MDMA (3,4-dimethoxymethamphetamine). Furthermore, this group is also referred to as amphetamine stimulants (ATS), although many compounds in this class do not stimulate the central nervous system. The best-known new drugs of this group belong to the so-called 2C-X series, where X stands for an atom or a chemical group substituted at position 4 (para) to the benzene ring of 2,5-dimethoxyphenethylamine. Their representatives include the following: 2C-B (4-bromo-), 2C-I (4-iodo-), 2-C-T-2 (4-ethylthio) – Kaizer-Będkowska, Kucia (2017), Puchałowicz et al. (2018).

TRYPTAMINES

The tryptamines synthesised today are copies or analogues of natural neurotransmitters in plants, fungi and animals, known since the 1950s. In the tryptamine molecule and its derivatives, we can distinguish an indole ring attached to an amino group with a two-carbon aliphatic chain. We can group tryptamine derivatives, among others, into simple tryptamines (without substituent in the indole ring, having a substituent in position 4 of the ring and a substituent in position 5) as well as the so-called ergolines (Kaizer-Będkowska, Kucia 2017).

PIPERIDINES AND PYRROLIDINES

Piperidines and pyrrolidines are organic chemical compounds from the group of heterocyclic compounds. Piperazines belong to a group of CNS stimulants structurally similar to amphetamine. Their mechanism of action is related to an increase in dopamine and norepinephrine concentrations through an increase in their release with simultaneous inhibition of reuptake (Kaizer-Będkowska, Kucia 2017).

The most commonly detected psychoactive substances in Poland in 2017 are presented in Table 3.

Table 3

Most frequently detected psychoactive substances in Poland in 2017 according to the Chief Sanitary Inspectorate (Chief Sanitary Inspectorate Report 2017-2018)

Name of the substance	Substance group	%
4-CEC	synthetic cathinones	17.68
NiPP	synthetic cathinones	12.37
HEX-EN	synthetic cathinones	10.83
5F-ADB	synthetic cannabinoids	7.87
PV8	synthetic cathinones	6.72
NEP	synthetic cathinones	5.70
MDMB-CHMICA	synthetic cannabinoids	4.11
3-CMC	synthetic cathinones	4.07
4-CMC	synthetic cathinones	3.58
NEMNP	synthetic cathinones	2.25

ADVERSE HEALTH EFFECTS

New drugs (NRD/NPS) enter the market without any studies on their toxicity or toxicokinetics. Unknown effects of these drugs pose a direct threat to health and even loss of life of their users. In terms of their effects on the human body, new psychoactive substances (NPS) can be divided into compounds with stimulant, psychedelic and dissociative effects.

Unfamiliarity of the ingredients applied in the production of new drugs (NRD/NPS) poses the greatest danger to users of these substances. Most frequently, they cause overexcitement, feelings of relaxation and even psychedelic and hallucinogenic states. Taking into account the fact that some new drugs (NRD/NPS) are multicomponent, this enhances their effects and – at the same time – makes the detoxification process more difficult (Lubecka et al. 2019). New drugs (NRD/NPS) are not well-known taking into consideration their physicochemical properties as well as their effects on the human body, which poses a risk to life and health (Więckiewicz et al. 2020).

Use of cathinone derivatives can lead to acute toxic effects, particularly impairment of the cardiovascular function (e.g. changes in blood pressure, cardiac arrhythmias), including disorders resulting in loss of consciousness and cardiac arrest. Synthetic cathinones are most commonly administered intranasally, by snorting the powdered form and absorption through the nasal mucous membranes, as well as orally, mostly in the form of tablets, capsules, solutions or injections (Kaizer-Będkowska, Kucia 2017, Więckiewicz et al. 2020).

The most common symptoms following the use of synthetic cannabinoids may include cardiovascular dysfunction, kidney damage and acute respiratory changes. The use of products containing synthetic cannabinoids can be similar to those induced by cannabis preparations, that is mood swings and well-being changes, impaired motor coordination, nausea, dizziness, or apathy and delusions. Moreover, their long-term use is considered to be associated with a higher risk of developing tolerance and addiction than in case of using the cannabis herb (Bialas et al. 2017).

Negative effects of opioids on the human body are well-known. Use of opioids can have serious health consequences that include development of tolerance and addiction as well as respiratory depression, which can result in death. Noted symptoms after taking opioids include euphoria (narcotic effect), psychomotor slowing of breathing and heart rate, analgesia, dizziness or concentration problems. As a result of their enormous effect on the nervous system, they cause a reduced temperature of the whole body, constriction of the pupils and abolition of their reaction to light, abolition of the cough reflex, bradycardia, severe hypotension, vasodilation and inhibition of intestinal peristalsis, which puts the body into a state of hibernation (Pasternak et al. 2015). In acute intoxication incidents, there is a depressive effect on the central nervous system, demonstrated by decreased activity, to an occurrence of deep coma. There is a reduction in blood pressure, bradycardia, analgesia, nausea and vomiting. Paralysis of the vasomotor and respiratory centres occurs, resulting in possible death (Bialas et al. 2017).

The most serious side effects of use of benzodiazepines include depressant effects on the central nervous system. Their side effects are dizziness, drowsiness, impaired motor coordination and muscle weakness (Perzyński et al. 2015).

Substances belonging to the phenylethylamine group display psychoactive effects (stimulants, psychedelics, empathogens), based on changes in the levels of monoamines, which are neurotransmitters in the central nervous system. Substances such as MDAT (methylenedioxy-2-amino-tetraline) or NRG-2 show amphetamine-like effects. Other substances belonging to this group include 'Ivory Wave' (deoxypipradrol) and 'Bromo-dragonfly'. The latter induces a strong hallucinogenic effect accompanied by paranoid symptoms and mood disorders (Gibbons 2012, Kaizer-Będkowska, Kucia 2017).

Table 4 presents the identified psychoactive substances divided into groups contributing to deaths in 2019, while Table 5 shows the most com-

Table 4

Identified psychoactive substances by groups contributing to deaths in 2019 according to the Chief Sanitary Inspectorate (Chief Sanitary Inspectorate Report 2019)

Psychoactive substances	Number of deaths
Classic drugs	67
Opioids	48
Cathinones	28
Benzodiazepines	23
Cannabinoids	7
Phenylethylamines	2
Piperazines	2
Other	15

monly observed adverse reactions to intoxication with new psychoactive substances from the group of synthetic cathinones. Table 6 presents the most frequently observed adverse reactions to intoxication with new psychoactive substances from the group of the synthetic cannabimimetics.

As life has shown, the market for new drugs (NRD/NPS) can be compared to the development of civilisation. Consequently, it is not possible to describe and present all substances that appear on the market. This is because each day new compounds which according to current legislation can be classified as new drugs (Act 2005) are created. The above means that the problem of new drugs is a current challenge for public health and education, despite undertaken legal, preventive and prophylactic measures.

CONCLUSIONS

The reviewed toxicology of described new drugs (NRD/NPS), although covering only their small proportion, unambiguously suggests that these compounds constitute a real and serious health threat to society. The num-

Table 5

Symptoms in the course of intoxication with synthetic cathinone psychoactive substances in the course of toxic syndrome (Lubecka et al. 2019)

Synthetic cathinones	
Adverse effects	from the most frequently observed to the rarest
Psychiatric	agitation (50-82%)
	aggression (57%)
	hallucinations (27-40%)
	disorientation (14-34%)
	fear (15-17%)
	insomnia (4%)
	catatonia (1%)
	anhedonia (BD)
Cardiovascular	tachycardia (22-56%)
	hypertension (4-25%)
	palpitation (11-28%)
	chest pain (6-28%)
	dyspnea (8-11%)
Neurological	headache (5-17%)
	pupil dilation (7-13%)
	blackout (8-12%)
	paresthesias (4%)
	convulsion (2-4%)
	dystonias (2%)
	shiver (2%)
Metabolic	hyponatremia (BD)
	hypokalaemia (4%)
	acidosis (1%)
Gastrointestinal	nausea, vomiting (5-22%)
	abdominal pain (2-5%)
Renal	elevated creatine levels (1-5%)
	acute kidney injury (BD)

BD – lack of data

ber of identified new drugs (NRD/NPS) continues to grow, similarly to the interest in their use. The profile of abused psychoactive substances is constantly changing. There is a lack of structured information on the scale of the phenomenon, its epidemiology or the harm related to the use of these substances. As a result, knowing the negative effects of new drugs (NRD/NPS), it is extremely important and legitimate to educate the society

Table 6

Observed toxic effects in the course of poisoning with new psychoactive substances from the group of synthetic cannabimimetics (Lubecka et al. 2019)

Synthetic cannabimimetics	
Adverse effects	from the most frequently observed to the rarest
Psychiatric	agitation (19-41%)
	hallucinations (11-38%)
	fear/panic attacks (21%)
	disorientation (9-14%)
Cardiovascular	tachycardia (37-76%)
	hypertension (10-34%)
	changes in ECG (2-14%)
	chest pain (7-10%)
Neurological	dizziness (9-24%)
	consciousness disorders (2-17%)
	drowsiness (17-19%)
	hypoaesthesia/paresthesias (2-10%)
	contractions/muscle fasciculations (7%)
Metabolic	hyperglycaemia (31%)
	hypokalaemia (28%)
	other electrolyte disorders (2%)
Gastrointestinal	nausea, vomiting (9-28%)
Renal	renal failure (BD)

BD – lack of data

at each stage of its development. It is vital to disseminate all the information about their potential harm, especially among young people. It should be remembered that despite prevailing global drug policies, new drugs are still being produced and consumed, which undoubtedly poses a major challenge to law enforcement, public health institutions, education, contemporary toxicology and curative medicine.

Author contributions

J.C. – research design. J.C., J.B-B., B.W, I. Ż-D. – data analysis, and writing the manuscript. All authors have read and approved the manuscript.

Conflicts of interest

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

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