REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625
v.7, n.1, 2026

PLASTICS USED IN DENTAL CLINICS AND IRREGULAR DISPOSAL: REVIEW ON ENVIRONMENTAL IMPACTS AND CHALLENGES IN HEALTHCARE WASTE MANAGEMENT

PLÁSTICOS UTILIZADOS EM CLÍNICAS ODONTOLÓGICAS E O DESCARTE IRREGULAR: UMA REVISÃO SOBRE IMPACTOS AMBIENTAIS E DESAFIOS NA GESTÃO DE RESÍDUOS DE SERVIÇOS DE SAÚDE

PLÁSTICOS UTILIZADOS EN CLÍNICAS ODONTOLÓGICAS Y LA ELIMINACIÓN IRREGULAR: UNA REVISIÓN SOBRE LOS IMPACTOS AMBIENTALES Y LOS DESAFÍOS EN LA GESTIÓN DE RESIDUOS DE LOS SERVICIOS DE SALUD

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e7166
https://doi.org/10.71328/jht.v7i1.66

PUBLICADO: 02/2026

ABSTRACT
The use of disposable plastic materials in dental clinics has intensified in recent decades due to biosafety and infection control requirements. Although essential to clinical practice, these materials generate waste that, when improperly disposed of, leads to environmental impacts and public health risks. This study aimed to analyze, through a literature review, the main types of plastics used in dentistry, their classification as healthcare waste, the environmental and health impacts of improper disposal, and the sustainable alternatives discussed in the literature. Searches were conducted in the SciELO, PubMed, and Google Scholar databases using descriptors related to dental waste, disposable plastics, and sustainable dentistry. The results indicate that improper disposal remains frequent, especially in small and medium-sized clinics, due to management failures, lack of regulatory oversight, and insufficient professional training. It is concluded that dentistry plays a strategic role in the adoption of sustainable practices, requiring integration between legislation, environmental education, and professional ethical responsibility.

KEYWORDS: Dental waste. Healthcare waste. Disposable plastics. Environmental impact. Dentistry.

RESUMO
O uso de materiais plásticos descartáveis nas clínicas odontológicas intensificou-se nas últimas décadas em razão das exigências de biossegurança e controle de infecções. Embora essenciais à prática clínica, esses materiais geram resíduos que, quando descartados de forma inadequada, produzem impactos ambientais e riscos à saúde pública. O objetivo deste estudo foi analisar, por meio de uma revisão da literatura, os principais tipos de plásticos utilizados na odontologia, sua classificação enquanto resíduos de serviços de saúde, os impactos ambientais e sanitários do descarte irregular e as alternativas sustentáveis discutidas na literatura. Foram consultadas as bases SciELO, PubMed e Google Scholar, utilizando descritores relacionados a resíduos odontológicos, plásticos descartáveis e odontologia sustentável. Os resultados indicam que o descarte irregular permanece frequente, especialmente em clínicas de pequeno e médio porte, devido a falhas na gestão, fiscalização e capacitação profissional. Conclui-se que a odontologia

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REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology – JHT – ISSN 2764-7625
v.7, n.1, 2026

possui papel estratégico na adoção de práticas sustentáveis, sendo necessária a integração entre legislação, educação ambiental e responsabilidade ética profissional.

PALAVRAS-CHAVE: *Resíduos odontológicos. Resíduos de serviços de saúde. Plásticos descartáveis. Impacto ambiental. Odontologia sustentável.*

RESUMEN
El uso de materiales plásticos desechables en las clínicas odontológicas se ha intensificado en las últimas décadas debido a las exigencias de bioseguridad y control de infecciones. Aunque esenciales para la práctica clínica, estos materiales generan residuos que, cuando se eliminan de forma inadecuada, producen impactos ambientales y riesgos para la salud pública. El objetivo de este estudio fue analizar, mediante una revisión de la literatura, los principales tipos de plásticos utilizados en la odontología, su clasificación como residuos de los servicios de salud, los impactos ambientales y sanitarios del descarte irregular y las alternativas sostenibles discutidas en la literatura. Se consultaron las bases de datos SciELO, PubMed y Google Scholar, utilizando descriptores relacionados con residuos odontológicos, plásticos desechables y odontología sostenible. Los resultados indican que el descarte irregular sigue siendo frecuente, especialmente en clínicas de pequeño y mediano porte, debido a deficiencias en la gestión, la fiscalización y la capacitación profesional. Se concluye que la odontología desempeña un papel estratégico en la adopción de prácticas sostenibles, siendo necesaria la integración entre la legislación, la educación ambiental y la responsabilidad ética profesional.

PALABRAS CLAVE*: Residuos odontológicos. Residuos de los servicios de salud. Plásticos desechables. Impacto ambiental. Odontología sostenible.*

INTRODUCTION

The increasing use of disposable plastic materials in dental clinics is closely associated with biosafety requirements, cross-infection control, and the optimization of clinical care delivery. Such materials have become widely integrated into routine dental practice due to their low cost, ease of use, and effectiveness in reducing biological risk. However, the growing reliance on disposable products has led to a substantial rise in plastic waste generation, and inadequate waste management has resulted in significant environmental and public health impacts (CONSELHO FEDERAL DE ODONTOLOGIA, 2017; KUMAR; SMITH, 2017).

Although specific regulations exist for the management of healthcare waste, improper disposal remains a reality in many dental care facilities. This situation contributes to environmental contamination, the formation of microplastics, and the exposure of healthcare workers and the general population to biological hazards (ANVISA, 2018; BRASIL, 2010).

In this context, an integrated analysis is required to examine the use of plastics in dentistry, their management as waste, and the feasible sustainable alternatives within the oral health care setting.

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METHOD

This study is characterized as a narrative literature review, allowing for the synthesis of theoretical and regulatory knowledge on the topic. Literature searches were conducted in the SciELO, PubMed, and Google Scholar databases. The following descriptors were used in Portuguese, English, and Spanish: dental waste; healthcare waste; disposable plastics in dentistry; environmental impact of plastics; sustainable dentistry (SILVA et al., 2020; JANIK-KARPINSKA et al., 2023).

Scientific articles, technical documents, and legal regulations published between 2008 and 2024 were included, provided that they directly addressed the use of plastics in dental practice, their classification as waste, and the environmental and public health impacts associated with improper disposal. After screening titles, abstracts, and full texts, the selected studies were qualitatively analyzed and organized into thematic categories.

RESULTS AND DISCUSSION

PLASTICS USED IN DENTAL PRACTICE

Plastic materials used in dentistry primarily include polypropylene, polyethylene, polyvinyl chloride, polystyrene, and polycarbonate. These polymers are commonly found in disposable syringes, saliva ejectors, dental cups, protective barriers, packaging of sterilized materials, gowns, masks, gloves, and auxiliary devices (PATEL; DESAI; SHAH, 2019; SILVA; OLIVEIRA, 2017).

At the global level, dentistry is estimated to generate between 2% and 5% of total hospital plastic waste. Considering that the healthcare sector produces approximately 85 million tonnes of waste annually worldwide, of which about 30% is plastic, the volume attributable to dentistry may range from 0.5 to 1.3 million tonnes of plastic waste per year. This waste predominantly consists of polypropylene, polyethylene, and PVC derived from single-use disposable items (WHO, Safe Management of Wastes from Health-Care Activities, 2004).

In Brazil, data from ANVISA and the Brazilian Institute of Geography and Statistics (IBGE, 2023) indicate that healthcare services generate approximately 250,000 to 300,000 tonnes of waste annually, with plastics accounting for around 25% to 30% of this total. Dentistry contributes, on average, 3% to 4% of this volume, which corresponds to an estimated 2,000 to 3,500 tonnes of dental plastic waste discarded each year nationwide.

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At the level of individual practices, a small- to medium-sized dental clinic may generate between 1 and 2 kg of plastic waste per day, equivalent to approximately 250 to 500 kg per year. This amount varies according to the number of patient visits, the clinical profile of the practice, and the extent to which disposable materials are adopted.

These figures underscore that, although the unit volume of waste generated may appear relatively small, the cumulative impact of the intensive use of disposable plastics in dentistry is environmentally significant. This is particularly relevant when considering the non-biodegradable nature of these polymers and the limitations of segregation and recycling systems for healthcare waste (THOMPSON et al., 2009; SILVA et al., 2020).

The physicochemical properties of these materials—such as mechanical strength, impermeability, flexibility, and low cost—justify their widespread use in dental practice. However, these same characteristics render plastics highly persistent in the environment, hindering natural degradation processes and exacerbating environmental impacts when disposal is inadequate.

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A



B



C

(A)Source: Centers for Disease Control and Prevention (CDC). Healthcare-associated waste images. (B) Source: National Health Surveillance Agency (ANVISA). Manual for the Management of Healthcare Waste. Brasília, 2018.(C) Source: United Nations Environment Programme (UNEP). From Pollution to Solution: A Global Assessment of Marine Litter and Plastic Pollution. Nairobi, 2021.

CLASSIFICATION AND MANAGEMENT OF DENTAL WASTE

Waste generated in dental clinics is classified as healthcare waste and must comply with specific regulations regarding segregation and final disposal. A significant proportion of plastic waste comes into contact with saliva, blood, and other bodily fluids and is therefore classified as potentially infectious. Such waste requires appropriate treatment prior to final disposal (CONAMA, 2005; ANVISA, 2018).

Despite the existence of clear regulatory guidelines, many dental facilities fail to adequately implement a Healthcare Waste Management Plan. The lack of proper segregation leads to the mixing of contaminated waste with general refuse, thereby increasing environmental and public health risks.

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ENVIRONMENTAL AND SANITARY IMPACTS OF ILLEGAL DISPOSAL

The improper disposal of dental plastics contributes to soil and aquatic pollution, as well as to the formation of microplastics that accumulate within ecosystems. These microplastics can enter the food chain, adversely affecting wildlife and posing risks to human health (THOMPSON et al., 2009; SILVA et al., 2020).

From a public health perspective, the inadequate disposal of contaminated waste facilitates the dissemination of pathogenic agents, thereby exposing waste collection workers, informal recyclers, and the general population to health risks. Consequently, this issue represents not only an environmental concern but also a significant public health challenge.

a) Dissemination of infectious diseases

The improper disposal of contaminated dental waste may facilitate the transmission of viral hepatitis (hepatitis B and C), HIV, tuberculosis, and bacterial infections, particularly through sharps and materials contaminated with blood and saliva. This practice exposes waste pickers, collection workers, and the general population to significant health risks.Riscos de infecções e acidentes ocupacionais

Urban sanitation workers and informal recycling workers are exposed to cuts, puncture injuries, and direct contact with biological agents, thereby increasing the incidence of skin infections, abscesses, tetanus, and other occupational diseases.

b) Chemical contamination and toxic effects

Plastics such as polyvinyl chloride (PVC) and polycarbonate can release toxic substances, including phthalates and bisphenol A (BPA), leading to soil and water contamination. Chronic exposure to these compounds has been associated with endocrine disruption, hormonal imbalance, infertility, neurological disorders, and an increased risk of certain types of cancer.

The degradation of plastics generates microplastics that enter the food chain. In humans, these particles have been associated with inflammatory processes, oxidative stress, gastrointestinal alterations, potential immunological effects, and the exacerbation of chronic diseases.

c) Ecological impacts with repercussions on human health

Pollution of aquatic and terrestrial ecosystems adversely affects wildlife, reduces biodiversity, and compromises water and food resources. These environmental damages indirectly impact public

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health by contributing to food insecurity, contamination of food supplies, and an increased burden of diseases associated with environmental degradation.

Healthcare waste contains infectious agents that, in the absence of proper segregation and treatment, may transmit infections such as HIV, hepatitis B and C, tuberculosis, and other diseases to healthcare workers, waste collectors, and the general community.

Concrete examples that may be cited:

International case (India – dumping of medical waste):

•A hospital in Madurai was fined for the illegal disposal of hospital waste—including syringes and contaminated materials—into general municipal waste. Authorities warned that this practice posed a significant risk of infection transmission to the general population and sanitation workers (The Times of India).

Case in the United States:

•A company responsible for the improper incineration of medical waste was fined in Maryland for exposing surrounding communities to biohazardous materials, highlighting that inadequate healthcare waste management poses a tangible risk to public health.

Diseases and health conditions reported:

• Hepatitis B and C and HIV resulting from contact with infected sharps and contaminated waste (WHO; scientific literature).

• Tuberculosis and other respiratory and skin infections among waste collectors and informal recyclers (studies on informal waste collection).

• Proliferation of disease vectors and the occurrence of illnesses such as dengue, leptospirosis, and cholera in areas with inadequate waste disposal practices.

• Exposure to chemical pollutants generated by improper incineration, which has been associated with toxic and respiratory effects.

SUSTAINABLE ALTERNATIVES IN DENTISTRY

The literature highlights the need to incorporate sustainable practices into dentistry, in line with the concept of sustainable dentistry. Key strategies include reducing the excessive use of

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disposable materials, substituting them with reusable alternatives when technically feasible, developing biodegradable plastics, and implementing reverse logistics programs (KUMAR; SMITH, 2017; PATEL; DESAI; SHAH, 2019).

In addition, environmental education for dental professionals and the integration of sustainability as an ethical principle of dental practice are essential to promote structural changes within the sector.

CONSIDERATIONS

Evidence analyzed throughout this integrative review demonstrates that the intensive use of disposable plastics in dental practice, although essential for ensuring biosafety and infection control, represents a significant source of waste with a high potential for environmental and public health impact when improperly managed. Irregular disposal of these materials contributes to soil and water contamination, microplastic formation, and the exposure of workers and the general population to biological agents and harmful chemical substances, characterizing a problem that extends beyond environmental concerns and constitutes a public health issue.

The findings indicate that, despite the existence of a robust regulatory framework for healthcare waste management, substantial gaps persist in the implementation of Healthcare Waste Management Plans in dental clinics, particularly in small- and medium-sized practices. These shortcomings are associated with insufficient regulatory oversight, limited operational resources, and a lack of continuous professional training, which together contribute to inadequate practices related to segregation, storage, and final disposal of contaminated plastic waste.

In this context, dentistry assumes a strategic role in promoting sustainable practices by integrating biosafety principles with environmental responsibility and professional ethics. The adoption of sustainable alternatives—such as reducing the excessive use of disposable materials, replacing them with reusable options when technically feasible, encouraging the development of biodegradable polymers, and implementing reverse logistics programs—is essential to mitigate the identified impacts.

It is therefore concluded that overcoming the challenges associated with the improper disposal of dental plastics requires an integrated approach involving strengthened legislation, effective enforcement, continuous environmental education, and the ethical commitment of dental professionals. By aligning clinical practice with sustainability principles, dentistry can make a concrete contribution to environmental protection, the promotion of public health, and the development of more responsible and resilient healthcare systems.

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