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Abstract

Biodiversity is decreasing sharply. Human well-being depends on the interacting web of living species: if health providers are truly concerned about human health they also need to concern themselves with the health of the planet. Awareness of the relationship between global health and human health is improving and the dental team can contribute to environmental health and, in doing so, to the overall health of the people they care for.

Many dental practices have backyards that can perhaps be used more effectively to encourage biodiversity and provide food and shelter for many species. The frequency of lawn cutting could be reduced to improve biodiversity. Practices should consider creating areas of water or left-aside areas in their gardens or to store fallen leaves, dry wood and branches for composting, such areas will provide a natural habitat for a range of species. The dental practice could also include flora- and fauna-friendly structures in their building structure or surrounds.

Dental practices might also give thought to the type of ground covering they have. Traditional coverings do not provide potential for plants or wildlife to live, but a natural surface with some vegetation provides greater potential for small plants and insects to exist.

Environmental sustainability and biodiversity within the dental practice

The purpose of the British Dental Journal (**BDJ**) is to inform its readers of ideas, opinions, developments and key issues in dentistry. This paper forms part of a series of papers (7 in total) which have been requested by colleagues to help them as clinicians understand sustainability as it relates to dentistry. This paper focuses on biodiversity and how the dental team can become more sustainable. In the spirit of the BDJ it is hoped that these series of papers stimulates interest, debate and discussion and, ultimately, influence dentistry to become more environmentally sustainable.

Relationship between biodiversity and health

Human well-being depends very much on the interacting web of living species: if health care providers are truly concerned about human health they also need to concern themselves with the health of the planet.¹ Awareness of the links between quality of environment, climate change and human health is increasing. However, to date, much of the limited research on dentistry and environmental sustainability has focussed on carbon dioxide emissions and the impact of amalgam.^{2,3,4} Papers 2-5 within this series on sustainability within the dental practice focus directly and/or indirectly on these emissions.⁵ Even though the link between dentistry and encouraging biodiversity seems weak, there is a

significant amount the dental team can contribute to the health of the local environment and, in doing so, to the overall health of the people they care for.

Biodiversity means the variability among living organisms and the ecological communities of which they are part.⁶ In 2017 Ceballos et al published a review highlighting the significant decline in populations of most global vertebrate species, predominately due to a reduction in their habitat, which ultimately effects the ecosystems human society depends on.⁷ Around 30% of land vertebrates (reptiles, birds and amphibians) are losing population and habitat.¹ Within the UK, 15% of around 8000 species assessed are facing extinction, with renowned naturalist David Attenborough suggesting that the UK has lost more nature long term than the global average, making the UK one of the most nature-depleted countries in the world.⁸ Biodiversity declines are being recorded across all food chains. Between the 1950s and 2013, insect numbers in protected areas of Germany have plummeted 80%, likely due to widespread use of insecticides and habitat loss in the surrounding countryside. Similar losses in bee and insect-pollinated plant diversity are being recorded in the UK and the Netherlands.^{9,10,11,12}

Scientists provide many reasons for the reduction in the world's insect populations, notably the use of pesticides, the spread of monoculture crops, urbanisation and habitat destruction. As we rely on insects for a wide range of ecosystem services, the significant drop in insect populations we are seeing

could be disastrous as it impacts on the pollination of crops and wild plants, control of pest species, decomposition of waste and as food sources for other animals.^{11,13,14,15}

Within the overall NHS there is estate land surrounding NHS premises. The NHS Forest has over 150 sites across England coordinated by the Centre for Sustainable Healthcare to improve the public health and wellbeing, encourage greater social cohesion, and help initiate projects to use new and existing woodland for food, crops, reflective or exercise space and to encourage biodiversity.¹⁶ There is considerable evidence that greenspace can improve health across a number of different dimensions including mental health and physical health (in particular obesity, cardiovascular and respiratory health). The evidence is weak, but growing and is reviewed in recent papers by Markevych.¹⁷

There were 46 thousand dental practitioners registered in the United Kingdom during the period 2010-2017.¹⁸ Although there is no official information on land associated with NHS dental practices it is expected that a number of dental practices within the UK and Ireland have outside areas that can be perhaps used more effectively to encourage biodiversity. This paper is written mainly for dental practices with some external space, whether it be a large garden or a small lawn and provides advice on how to do this.

Importance of urban areas for biodiversity

Traditionally, urban spaces were considered significantly less important for maintaining the natural environment than rural areas. However, biodiversity can be high in urban areas too, providing opportunities for rich and varied plant and animal life to thrive.^{19,20} Ensuring there is high quality green space and biodiversity within towns and cities also provides benefits such as cleaner air and water and more attractive properties.²¹ As urban areas expand and rural areas decline, the value of urban biodiversity is increasing.^{22,23} From a sustainability perspective and within the dental setting, urban environments are divided into green space, grey space and brownsites.²¹ Bearing in mind the relevance to dental practices, only green and grey spaces will be discussed in this paper.

1. Greenspace

Green space within a city describes everywhere vegetation grows. Within a dental setting, the term describes any green area surrounding a dental practice.²¹ Green infrastructure encompasses the entire working landscape and has a crucial role to play in improving air quality, providing protection both against floods and heat in the summer and helping control pollution.²⁴

Gardens are significant contributors to urban biodiversity and can reduce urban fragmentation (the loss of connection between green space).^{25,26,27} This connectivity increases the area of continuous habitat and diversity of natural or

semi natural habitats that support native plants and animals.^{21,28} There is also growing evidence of the psychological benefits of seeing and caring for plants.²⁹

By contributing to the wider network of green space, gardens can help provide habitat for a variety of wildlife, including insects, birds and smaller mammals.²⁵ Gardens also contribute to a number of beneficial processes including regulating water drainage via their porous surfaces and reducing the effects of strong winds.³⁰ There are a number of types of greenspace including lawns, plants, left-aside areas, water, and the creation of simple structures for insects etc.

1.1 Lawns

In reality many gardens may be poorly equipped to perform these functions. In many countries there is still a tradition of having neat and tidy gardens, mown lawns and clean concrete areas, reliant on frequent weeding and application of insecticides. However, ‘weed’ species, such as clover and dandelion, are important sources of pollen for a wide range of beneficial insects, e.g. bees, that are also harmed by insecticides.³¹ A carefully manicured lawn is very poor from a bio-diversity perspective. The invertebrate conservation trust, Buglife, suggest that mown lawns should at least have a wild corner to attract wild flowers and insects.³² The frequency of lawn cutting should be reduced to improve biodiversity. Wild lawns should only be cut occasionally and infrequently fertilised as few herbaceous species can cope with the disturbance of grass mowing.³³

1.2 Plant type

When choosing plant types for a sustainable garden, the dental team should consider value of plants to optimise conditions and allow for reproduction of species, for example, by providing resources for bees and other pollinating insects.³¹ There is not a list of plants per se that will provide this function, but a biodiverse garden is one that produces a diverse range of flowers that bloom at different times of the year.^{23,33}

Native plants are the ideal. Depending on which country the dental practice is based in, herbs, fruits and vegetables may all produce valuable flowers. Fruit and herbs are all attractive to insects; e.g. berries, melon, squash, cucumber, blossoming trees, mint, rosemary and sage.³⁴ Non-scented commercial plant types, such as hybrid rose bushes, are not as attractive or beneficial to insects.

Herbaceous communities such as meadows and pastures have very high diversity and can be successfully replicated in small urban areas.²⁶

The use of pesticides should be avoided. A recent report by the United Nations highlights the dangers of pesticides and supports the use of other more biologically sustainable options.³⁵ When there is a real need to resort to pesticides, they should be used in a specifically targeted manner, for example to control invasive plants.

1.3 Left-aside areas

This strategy can be combined with left-aside areas, which can include piles of fallen leaves, dry wood and branches. These can look more conventionally attractive with careful stacking and/or arrangement. Woodpiles and/or fallen leaves within a garden provide resources for fungi, lichen and moss to flourish and are ideal habitats for insects, such as ground beetles, which act as pest managers of slugs.³⁰

A moderate level of management is needed to prevent these areas becoming totally overgrown by a species that reduces diversity but, for most of the year, the area would be very low maintenance. These areas provide nesting space for bumblebee colonies and overwintering shelter for a range of species, including hedgehogs.^{36,37,38} Set aside areas can also double as a location for a compost heap. If there is sufficient external space within a dental practice, tree canopies dramatically increase the volume of habitat space for many bird, insect and reptile species.

1.4 Water

There are various other elements the dental team could introduce into an outside area to improve sustainability. Areas of standing water, such as containers filled with water, or ponds can help attract insects, birds and amphibians. Larger areas provide habitats for frogs, toads and newts to live and reproduce.³⁹

1.5 Simple structures for insects, reptiles etc

Habitats for insects, including solitary bees, can be encouraged by making insect homes using bamboo canes tied together. If a box is used to hold the canes, it should be turned on its side and hung from a tree or a post at eye level, sheltered from the rain. Such 'bee hotels' provide valuable nesting space⁴⁰ but in some situations could lead to increased disease-spread or exploitation by invasive species (for more information check with your local insect conservation charity).⁴¹ Small reptiles and slowworms can be accommodated by placing strong canvas or other natural material, like compost heaps/piles of mown grass, in a corner of the garden.³⁰ Piles of stones and bricks provide an ideal environment for reptiles. Dental practices could also place bird food in bird feeders during winter months.

2. Grey space

Grey space within a town/city is the non-green elements, including buildings, footpaths and roads. There are a number of ways these areas can be adapted to reduce the impact of growing urban sprawl on our environment, including green roofs, green walls, balconies, balconies, roof eaves and living ground coverings.⁴²

2.1 Green roof

A green roof (also known as a living roof, brown roof or biodiverse roof) is a relatively inexpensive option to improve the sustainability of a building. Green

roofs are designed to allow growth of different vegetations.⁴² Creating a green roof can be as simple as rolling out matting or wildflower turf, or can be more specialised; websites such as Blackdown⁴³ offer a full range of options. These roofs aim to replicate a natural growing environment for plants without being overly heavy and can also be used on smaller structures, like sheds. By planting a diverse range of plants, they are beneficial to urban biodiversity.²⁶ The roof structure can be quite low maintenance, especially if stress-tolerant plant species are used.⁴⁴ Green roofs help mitigate the urban heat island effect (an urban area, like London, is significantly warmer than surrounding countryside) and help with both energy conservation and storm water management.^{45,46}

2.2 Green walls

Green walls are vertical systems of green foliage. They can be found on any type of vertical surface, attached directly to buildings or free-standing.⁴⁷ Plants can have their roots in the ground, the wall itself or in an inert medium. These systems are suitable for small spaces and create unique ecosystems that enable underexploited vertical space to be used to grow plants and provide a habitat for insects and smaller animals.⁴⁸

2.3 Balconies

Some dental practices may have balconies; this space could be used for pot plants including herbs, flowering plants or grasses. Where there is room fruit

and vegetables can be grown to provide locally sourced food, further adding to the biodiversity and the overall network of green space.^{29,49}

1. Roof eaves

Many bird species and bats are under threat as their natural nesting sites are disappearing in urban areas.⁵⁰ The eaves of a roof can be used to place artificial nest boxes for birds and bats and can easily be incorporated into new buildings or extensions. There are many types of ready-made nest boxes and the provision of different sized boxes for different bird species is recommended. Correct positioning of the boxes is vital to their success and factors such as the type of species to be supported, site height, direction of sunlight and prevailing wind (as well as its proximity to fresh water for a bat box) should be considered.⁵¹

2. Ground covering

Dental practices should consider the type of ground covering they use within any outside area. Traditional road coverings such as concrete or tarmac does not provide any opportunity for plants and wildlife to live. Such ground covering also increases the risk of flooding as the surface will not absorb any water.

Dental practices could consider partially sealed surfaces, for example, gravel with grass coverage and/or non-sealed paving. Combining a useable surface with some vegetation provides greater potential for small plants and insects to exist.

Barriers and Facilitators

There are however a number of barriers and facilitators for the dental team to incorporate biodiversity changes in their open spaces. In a recent study by Harford, dental members who completed a questionnaire were very interested becoming more environmentally sustainable, however a lack of awareness on how best to accomplish this.⁵² It is also clear from the latest NHS staff study that 98% staff think that it is important for the health and social system to work in a way that supports the environment. In Harford's research 77% of all dental team responded that they were interested in environmental sustainability.

A recent paper by Grose highlighted some of the barriers to implementing sustainability changes within dental practice.⁵³ Practice barriers including competing demands, personal motivation and the cost and time to implement these changes as well as patients questioning the choice of the surgery to remove the lawn and replace it with something perhaps more wild and unkempt.⁵⁴ From a biodiversity perspective there are limited papers demonstrating cost benefits of providing a bio-diverse space. It is known that trees, by providing shelter and shade, can contribute to a reduction in a building's energy budget, through reduced air conditioning, and improved solar gain⁵⁵. In an American study it was demonstrated that once a native grassland was established there was no mowing, no requirement of fertilisers, pesticides, herbicides or watering; resulting in annual long term cost reductions of around

80-90% in comparison to the costs of traditional lawn mowing and maintenance.⁵⁶

The practice also needs to consider the time constraints inherent in producing a biodiverse garden. These may be high in the short term, but over the long term is more likely to be less time intensive than lawn mowing. NHS Forests works with volunteer organisations such as the British Trust for Conservation volunteers who have developed the Guidance Pack for the organization. It is possible that patient groups or local schools could help support the development and maintenance of the greenspace of a dental practice on a voluntary basis. Some patients may not have a garden of their own and be grateful for the opportunity. Evidence from this comes from the experience of the Lambeth GP food coop and increasing waiting lists for allotments.^{57,58} They could share in any food produce produced by the garden. The development of a green biodiverse space, like all sustainability initiatives would need to be led by a team member passionate about championing this change. As discussed in the 7th paper in this series any sustainability initiative needs to have senior leadership with the team member feeling incentivised and support to make change.

An example of existing practice (although not within dentistry) is the Lambeth food cooperative, an inclusive open project, the result of a collaboration between 45 GP practices in Lambeth. Patients are supported by an

experienced gardener to learn how to grow fruit and vegetables and in the process interact with other people. Patients are encouraged to join, attending sessions run by practice nurses. The vision of Lambeth is to develop a vision of new environments for health and well-being, for galvanising local communities and building the potential for greater resilience, and reduce social isolation and health inequalities. The cooperative supports the growth of a variety of foods. Further details are available on their website.

It may be possible for dental practices to seek charitable funding or work in partnership with health insurance companies. One example of this is the partnership between Bupa and the Royal Society Protection Birds (RSPB) which is transforming greenspaces and encouraging wildlife into healthcare and residential environments.⁵⁹

Alternatively the practice could consider professional help to develop an eco-friendly space for the practice, using existing funds they currently spend on lawn installation etc . There are a number of companies online that specialise in ecological gardens..

The transition to an environmentally friendly dental practice environment need not be an all or nothing dichotomy. By incorporating measures that are logistically feasible into the day to day running of the practice we can all take steps toward improving both ecological and human well-being.

Action points

The following Action box (see Box 1) provides some summary for readers to consider to improve their biodiversity. The reader should be advised that the judgement of ease, cost and impact is subjective, and more evidence is needed.

Box 1: Action on biodiversity

Insert Box 1 here.

Three main points from this paper:

- Human well-being depends on the health of the biosphere planet.
- Many dental practices have outside areas that could be used to encourage biodiversity, provide benefits such as cleaner air and water and create a more attractive property.
- To encourage biodiversity, dental practices could provide wild areas (ponds, trees, wood and fallen leaf piles) as a preference to lawns and concrete and also incorporate building structures, such as green roofs, green walls, modified brick and roof tiles, balconies and roof eaves.

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











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Box 1: Action box; Biodiversity

		£		
Provide greenspace in your outdoor area		££		
Stopping mowing your lawn as often		£		
Choose plant and insect friendly plants		££		
Choose native plants		££		
Leave left aside areas (piles of fallen leaves, branches)		£		
Think about providing insect habitats (bug hotels)		££		
Avoid pesticides		£		
Create a green roof or wall		££		
Plant out the balconies		££		
Place nest boxes in the roof eaves		££		
Lose the concrete or tarmac and allow ground coverings to be porous and living		£££		
Implementation:				
Easy  Less easy 				
Investment costs: low £ ... high £££				
Financial return on investment (ROI):				
Low  ... High 				
Environmental benefit:				
Small  ... Large 				

The following Action box (see Box 1) provides a summary for readers to consider. The reader should be advised that the judgement of ease, cost and impact is subjective, and more evidence is needed.