

Review

Administration of the Effects of Wireless Electromagnetic Fields on Living Tissues in Sustainable Urban Ecosystems

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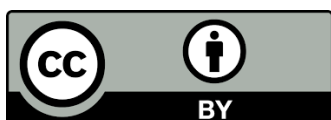
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Abstract

A relevant objective of managing an electromagnetic (EM) device is to improve its expected results and reduce its undesirable side effects. In this context, this paper aims to evaluate the interest of the two One Health and Responsible Attitude methods in the daily practice of wireless transmission (or transfer) in EM energy devices. These approaches are respectively linked to device eco-design and optimization, as well as to the protection of biodiversity and ecosystems against device side effects related to EM field (EMF) radiation. The present review aims to evaluate the significance of these approaches in administering the augmentation of planned results while lessening the unsolicited ones, in the practice of wireless transference in EM energy tools, in the background of an urban situation. The exploration focuses specifically on two phenomena involved in urban environments and likely to disturb living tissues engaged in biodiversity, including humans, animals, plants, flowers, etc. The first concerns the effects of EMF radiation or noise from communication devices on detecting and assisting tools near or onboard living tissues of biodiversity. The second concerns the harmful biological effects of wireless battery-charging energy-transfer devices onboard electric vehicles on the living tissues of biodiversity. The results of the analysis suggest that the fusion of these approaches enables sustainable and reliable urban use of wireless electromagnetic devices, which is perfectly coherent with their design, which is compatible with the



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preservation of biodiversity and its ecosystems. The various topics in this paper, while autonomous, are supported by literature examples, enabling a deeper understanding.

Keywords

Electromagnetic energy transportation; one health - responsible attitude concepts; electromagnetic interference; urban ecosystem; living tissues committed devices; wireless charging; harmful biological effects

1. Introduction

All over the past, humans have sought to enhance their good fortune, including comfort, health, and security. This has been attained through different advances in committed devices and natural resources exploitation. Such devices operate with diverse energy sources. For several decades, electromagnetic (EM) power has gained significant ground, growing over time. EM energy has been generated from diverse sources, predominantly fossil fuels. Recently, human good has been reflected to be linked to biodiversity and ecosystems in a green background. Such a framework can be accomplished within clean energy conversion to EM energy alongside EM devices' eco-design, which relates to a sustainable usage of such devices. Accordingly, execution is augmented, resources are economized, and harmful outcomes for humans in their environmental biodiversity are diminished; these features reveal the Responsible Attitude (RA) tactic. Actually, the practice of EM devices has planned consequences that are commonly linked to unsolicited side effects. Such antagonistic special effects imply exposure to radiated and stray EM fields (EMFs) that might disrupt various tools, including health tools, and create hostile biological effects (BEs) in tissues of high biodiversity, revealing the One Health (OH) concept [1, 2].

Relating to the town green background, the troubles above are triggered by EMF exposure, which could be as a result of, for instance, wireless transmission, e.g. [3], motion, e.g. [4], or energy-transfer devices [5, 6] generally expended in everyday living. Various classes of radiation are associated with devices involving wireless energy transmission or transfer. Those are linked to the distance, power, frequency, the radiated entity character, and its location. Regarding small wireless communication apparatuses, for instance, mobile phones, they require little power, radio frequency (RF), and can be near the subject being radiated. In this situation, such exposure will be concentrated in a small area of the object. Concerning antenna towers of mobile phones, they engage greater powers, however distant from the objects under exposure that would be uniform [7, 8] or on the whole object [9]. Relating to wireless transfer of energy via, for instance, inductive power transfer (IPT), which reflect a wide range of power, as of some watts for slight domestic tools batteries charging [10, 11] towards some kilowatts in electric vehicles (EVs) counting autos, buses, trucks, ships, etc. [12, 13], the span of transfer is insignificant (as of a few mm to some cm) With a minor frequency (up to 300 kHz). The subject, probably troubled by IPT stray fields, might be as little as a cm for minor IPTs and around 1 m for on-board IPTs of the EVs. EMFs radiations of wireless power transference generally can disturb diverse living tissues of whole biodiversity either directly, causing tissues BEs controlled by standards restricting the field order [13], or not directly affecting the performance of tissues involved devices [14, 15].

The present paper aims to evaluate the significance of RA and OH methodologies in achieving the augmentation of planned results while minimizing unsolicited ones in the practice of wireless transmission in EM energy tools in the context of urban environments. The paper sections will investigate and illuminate such administration. Section 2 recapitulates the diverse disruption effects of exposure to non-ionizing EMF on diverse tools and living tissues. Section 3 addresses the positions of RA and OH tactics in EMF management for wireless EM tools. Section 4 involves the material occurrences and the ruling numerical representations associated with EM tool design and the assessment of the effects of the emitted EMFs. Section 5 is dedicated to both wireless transfer and transmission tools examples exploited in the urban background. Sections 6 and 7 are respectively related to the discussion and conclusions. The different investigations followed in the paper are assisted by literature instances.

2. Disturbance Effects of EMF Exposure

In various circumstances, EMFs are widely used in many friendly applications and are effectively used in medical activities. These EMFs might perturb the functioning of devices and produce hostile BEs in living tissues, which are tightly linked to the characteristics of the concerned matter and the EMF. The strength and frequency represent EMF, while the material and shape belong to the substance. EMF radiation effects can be divided into two scenarios based on frequency range. The first overlaps the range of radio, microwave, and infrared waves, which exhibit non-ionizing behavior. At the same time, the other encompasses the range of ultraviolet, X, and gamma rays, which produce ionizing radiation. Radiation on living tissues involved in the last case would trigger dangerous antagonistic health influences by creating tissue damage. The non-ionizing EMF category can operate safely in many situations; however, it can also cause harmful effects, particularly when field intensities are disproportionate or radiation intervals are prolonged.

Wireless transfer and propagation in energy tools contain non-ionizing EMF radiations in the spans respectively of, up to 300 kHz low frequency and RF, $10^5 - 3 \times 10^{11}$ Hz. Two classes of EMF radiation are associated with the distance between the source and target. In the low frequency case, the source and the target are close and interacting in a near field manner, whereas in the RF case, the source is far away (about a wavelength), producing a far field radiation on the target.

In the instance of tissue objects, the radiation grade is gauged by the specific absorption rate (SAR) in W/kg. This power density denotes the intensity of EM energy converted into heat in a specified time. Such thermal consequence relates to the definite thermal tissues BE. The security criteria restrictions on EMF radiation relate to SAR, resulting in increased tissue temperatures and induced EMFs. These thresholds are based on the terms of the tissue and source, in addition to the conditions of exposure and interval. Such information assigns the particular tissue part, the radiated subject category, the character and interval of the radiation for the diverse conditions of the exposed object linked to its source relation (fabricator, consumer, user, nearby, etc.). As mentioned above, disproportionate field levels and intervals might crop outstanding SAR and uneven temperature growth, leading to hostile non-thermal BEs, likely triggering molecular disorders leading to tissue damage [16]. Regarding target tools, which are habitually safeguarded against EMF emissions in accordance with fabricator security conventions, the reliability of a tool can be certified through an electromagnetic compatibility (EMC) assessment. Medical appliances that function close to or are included in tissues are typical targets. Characteristic instances are static fixed-role onboard

detecting tools [17], dynamic organ stimulus tools [18], and magnetic resonance imaging (MRI) scanners exploited in assisted treatments and interventions [19]. An EMC check is required to settle the reliability of these therapeutic devices, distressed by an outside field or intrusive matters [14].

3. EMFs Management Through RA and OH Approaches

The approaches of RA and OH are allied to the sustainable design of both tools related to the source and the target, concomitant with the subject to be safeguarded. In such circumstances, the design goals are to enhance the general performance factors, such as power factor, efficiency, etc., and to diminish the troubling side effects of exposure. Such a design, further to the administration of the tool, is mainly connected to the OH and RA tactics, thus clarifying such an association [20]. The tool's operational management comprises process scheduling, thereby enabling sustainable, clean EM energy use and cost-effective valuation [21]. The aforementioned EMF exposures might modify the process of the radiated tools or crop BEs in the exposed living tissues [20]. These hostile effects can be bypassed by two techniques: through a sustainable device components design or by means of shielding equipment. These shields would be located between the source and the tool or tissue under exposure.

4. Physical Occurrences and Mathematical Representation

The occurrences ruling an EM tool design relate to EMF and electric circuit mathematical equations. The occurrences concerned in the device-exposed EMF are similarly connected to EMF and heat transfer (HT) spheres coupled through the EM power dissipated (P_d) in the involved substance. For living tissues, EMF radiation, a bio-heat (BH) occurrence, governs the BEs and the heating produced by the source P_d . Such diverse occurrences are governed by the equations presented in the following section.

4.1 Ruling Equations

Founded on Maxwell's local conduct, the differential configuration of the conventional EMF equations [22], under the form of EMF harmonic fields are provided by:

$$\nabla \times \mathbf{H} = \mathbf{J} \quad (1)$$

$$\mathbf{J} = \mathbf{J}_e + \sigma \mathbf{E} + j\omega \mathbf{D} \quad (2)$$

$$\mathbf{E} = -\nabla V - j\omega \mathbf{A} \quad (3)$$

$$\mathbf{B} = \nabla \times \mathbf{A} \quad \text{with} \quad \nabla \cdot \mathbf{A} = 0 \quad (\text{gauge}) \quad (4)$$

BH phenomenon, and heat source P_d are represented by the following equations:

$$c_p \partial T / \partial t = \nabla \cdot (k \nabla T) + P_d + P_t + c_f \rho_f p_f (T_f - T) \quad (5)$$

$$P_d = \omega \varepsilon'' E^2 / 2 \quad (6)$$

In (1-6), **H** and **E** are the magnetic and electric fields vectors in A/m and V/m, **B** and **D** are the magnetic and electric inductions vectors in T and C/m², **A** and **V** are the magnetic vector potential and electric scalar potential in Wb/m and volt. **J** and **J_e** are the total and source current densities vectors in A/m². The electric conductivity is signified by σ in S/m, the angular frequency by $\omega = 2\pi f$, with the frequency f in Hz. The character ∇ is a partial derivative vector operator. The behavior magnetic and electric laws, respectively, specified by **B/H** and **D/E** are denoted by the permeability μ in H/m and the permittivity ϵ in F/m. The symbol ϵ'' signifies the imaginary part of the complex permittivity ($j\omega\mathbf{D} = j\omega(\epsilon' - j\epsilon'')\mathbf{E}$), and ρ represents the material density in kg/m³. E denotes the electric field strength (absolute peak value) in V/m, c characterizes the material specific heat (at constant pressure) in J/(kg °C), k the thermal conductivity in W/(m °C), and T the temperature in °C. The dissipated power volume density in W/m³ provided by Equation (6) relates to the main dielectric EMF loss, and will be utilized in the coupling of EMF and BH equations. The BH equation (5) linked to living tissues, concerns a self-tissue heat source P_t (animal metabolic heat or internal heat in plant tissues), convective heat transfer via irrigating fluid (blood for animal and sap for plant), and an external heat source linked to the EMF exposure P_d all in W/m³. T_f and T are respectively the fluid temperature and the local temperature of tissue in °C, and c_f , ρ_f , and p_f are respectively fluid, specific heat in J/(kg °C), density in kg/m³, perfusion rate in 1/s. Note that (5) is comparable to Penne's bio-heat equation [23] related to living tissues of animal, counting convective heat transfer in blood.

The investigation of an EM tool, counting electric circuits, is linked to the EM equations (1-4), which are coupled to the circuit equation that under a general form:

$$v = 1/C \int i \, dt + ri + L di/dt + d\Psi/dt + \delta \quad (7)$$

In (7), v is a voltage source, i is the current in the circuit, r is the total resistance involved, L is the circuit linear inductance, C is a capacitance, δ corresponds to a non-linear voltage drop (e.g., a semiconductor constituent) in the circuit, and Ψ is the circuit flux linkage. The equations relating to the EMF and circuit matters to be solved are hence Equations (1-4, 7).

Actually, the design of EM devices and their exposure to external fields are linked to the mathematical equations of EMFs and electrical circuits (1-4 and 7). For living tissues exposed to EM radiation, the BH equation (5) governs the thermal BEs resulting from the dissipation of EM energy (6) due to external exposure. These BEs can be obtained by solving equations (1-4) coupled to (5) via (6).

4.2 Numerical Management

The solution of the equations in relation to the EMF, BH and electric circuit, respectively (1-4), (5) and (7), must count for particular characteristics of concerned structures. These include the complexity of geometry, material inhomogeneity, nonlinear behavior of variables, and their physical interdependencies, which require sophisticated computational approaches. Filling such traits imposes a local substance answer signifying the use of 3D discretized approaches, such as the finite element method (FEM) or analogous methods (BEM, FDTD, etc.) [24, 25], accompanied by appropriate equations combining policies. Consequently, an iterative weak coupling procedure, as a result of faraway time constants, of EMF and BH equations would be experienced via (6). In the

presence of an electric circuit, its combination with EMF would be potentiated by the simultaneous solution of equations, driven by near time constants [26].

5. Applications in Urban Environment

A significant share of the urban technologies is a vast set of transmitters, signal sources, and recipients. This section is dedicated to two appliances connecting to wireless EM wave propagation or energy transfer. The first explores the disturbances of wireless communication tools due to their EMF exposure on near or onboard living tissues, therapeutic devices projected for detecting or maintaining tasks. Such tools are used in health centers, hospitals, and at home for remote health care. They include wearable and body-closer devices for diverse supervision or therapy. The second application, related to urban mobility, concerns battery charging for EVs via wireless IPT. In the two applications, the aimed analysis concerns sustainable design, allowing medical tools guard against EMF exposure in the first, and the reduction of IPT stray fields and hence induced BEs in living tissues in the second. In the two instances, the concerned tissues are related to humans, animals, plants, etc., and are included in urban biodiversity. Note that in connected cities, the two appliances linked to mobility and healthcare might be administered via their associations with the urban smart network.

5.1 Close and Onboard Living-Tissues Devices

Body onboard tools are used in forms of wearable, removable, or incorporated, which can perform passive or dynamic appointments. The related actions are located in tissues of the whole town's biodiversity. They can execute sensing duties, e.g., inspection and forecasting, support tasks, e.g., maintenance and drug delivery, and serve as scanners implicated in image-guided interventions and therapies. The inspecting devices (sensors) are generally non-invasive, wearable, or separable, working in real-time, allowing nonstop surveillance of the concerned tissue and hence deliver fitting health data to conclude its complete condition and, additionally, primary health image evaluation. Additional individualized matters associated with disruptions of critical occupations, such as respiration rate, fluid circulation pressure, etc., might be recognized via removable smart devices. The sustaining devices are of two types, tissue embedded (in health upkeep and organs stimulation) or tissue enclosing (in image-guided interventions). The former concerns tissue stimulators, pumps, implanted cardiodefibrillators, pacemakers, etc., whereas the latter concerns imagers encompassing tissue portions for surgical or embedded drug delivery interventions.

5.1.1 Onboard Tools Sustainable Design

As mentioned above, EMF distress of a tissue-closed device might be avoided via eco-design either by handling its components or through shielding. Therefore, this might be accomplished by circumventing EMF-sensitive substances in device constituents; otherwise, shields must be employed. Humble conducting shielding protections might be utilized in the absence of temperature rise of adjacent living tissues due to their induced current heating. In such a case, an alteration of the simple conducting shield is necessary. Therefore, the usage of multifunctional fitted shield components authorizes low-reflectivity reduction of the robust field reflection caused by the excellent material conductivity [27]. The consequence of such eco-design, which relates to

RA and OH tactics, is a sustainable device with lessened hostile EMF influences. Figure 1 clarifies the significance of eco-design embracing OH and RA methodologies via onboard device design or shielding, encompassing the entire biodiversity by mitigating antagonistic urban EMF effects.

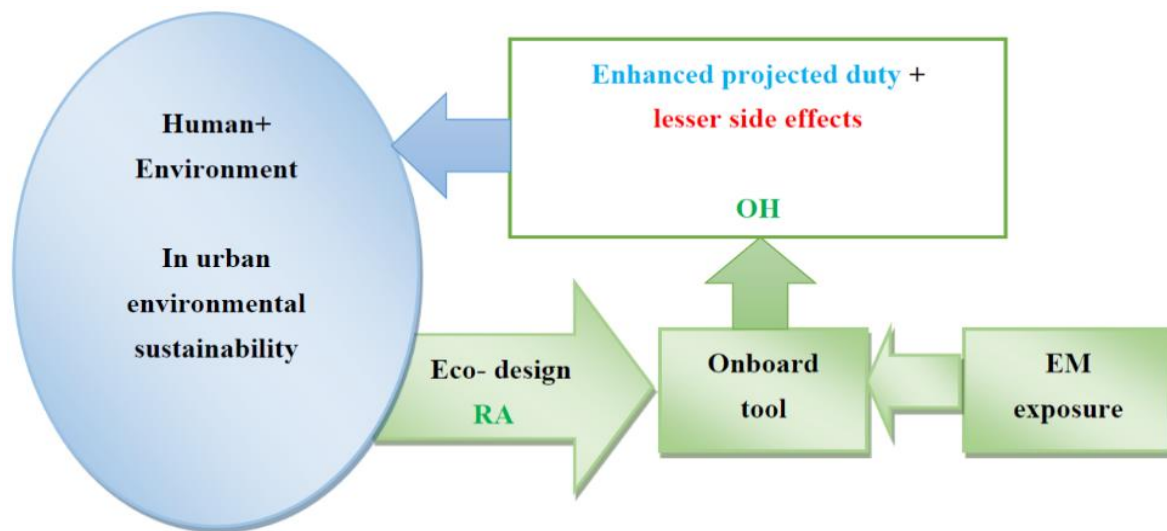


Figure 1 Management of hostile EMF effects through RA and OH methodologies related to the eco-design and usage of onboard devices, considering urban biodiversity.

5.1.2 Instance of Image-Guided Therapeutic Tools

Disturbances in the RF field B_1 distribution within the scaffold of an MRI, which is image-interrelated, are typically initiated by outside EMFs or by the incorporation of magnetic or conducting articles into the MRI scaffold; for more details of MRI scanner configuration, please see reference [14]. As a rule, in MRI-guided therapies or interventions, sole actuating means made up from non-magnetic and non-conductive materials, for instance, piezoelectric substances, are allowable (MRI-compatible substances). Generally, piezoelectric actuators [28] utilize their polarization under an electric field (inverse effect), with skinny electrodes of conducting metals. The placement of such electrodes vis-à-vis the field orientation determines a significant disposition associated with the impact of the electrode surface perpendicular to the field; thus, the greater this surface, the greater the disruption of the resultant field distribution. Such an incidence, which is connected to currents induced in the metal, could be utilized in the actuating outline to drop disturb in the RF field B_1 [14]. The inspection of this field distribution might be attained via EMC analysis through solving (1-4) and corresponding to the distributions with and without the hosted matter. Figure 2 shows the RF field B_1 (vertically oriented) distribution in the axial section of the birdcage interior of the MRI tunnel, at 63.87 MHz (consistent with the static magnetic field B_0 of 1.5 T), in the instance without matter. Figure 3 displays an example of a cubic piezoelectric substance with relative values of (μ , and ϵ) and σ of ($\mu_r = 1$, $\epsilon_r = [450990990]$, $\sigma = 0$ S/m) covered by tinny electrodes on two opposed faces with ($\mu_r = 1$, $\epsilon_r = 1$, $\sigma = 3.77 \times 10^7$ S/m) – Figure 3a. Figure 3b and Figure 3c display the distributions of the field B_1 in the two states with the electrodes respectively perpendicular and parallel to the field orientation. The influence of the conducting surface, in the latter case (parallel to the field), is radically reduced (Figure 2 and Figure 3c are about matching). The outcomes of Figure 2 and Figure 3 demonstrate a simple qualitative instance associated with

RA substance usage, circumventing antagonistic influences due to likely EMF noise image perturbation.

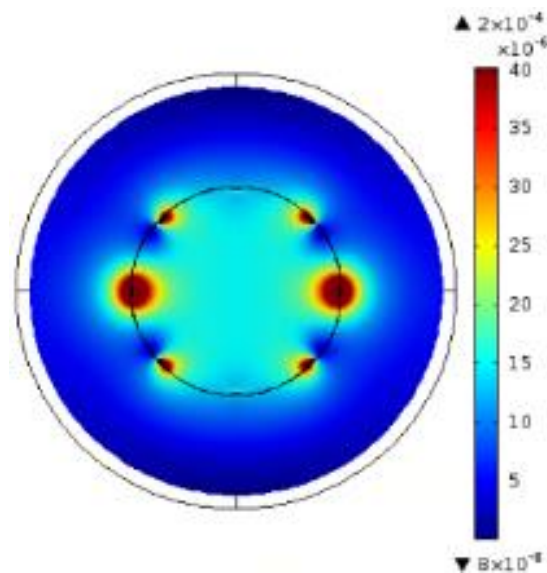


Figure 2 MRI RF (at 63.87 MHz, B_0 1.5 T) magnetic field B_1 (vertically oriented) distribution in the case without matter [14].

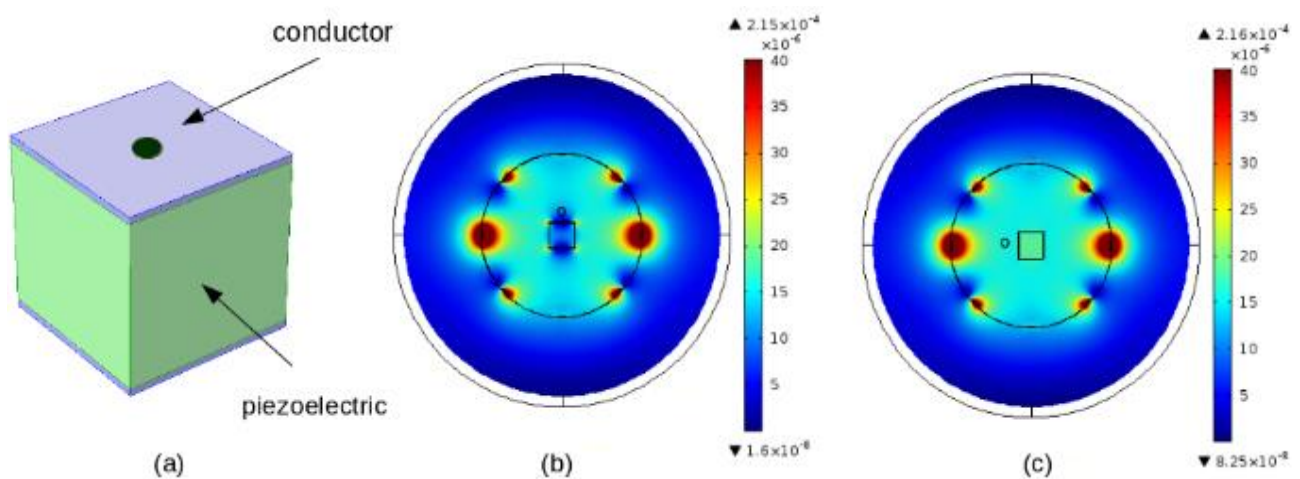


Figure 3 MRI RF field B_1 distribution with the incorporation of a piezoelectric covered by two-faced electrodes (a) matter shape (b) field distribution - electrodes perpendicular to the field (c) field distribution - electrodes parallel to the field [14].

5.2 EVs Wireless Batteries Charging Through IPT

A characteristic instance of clean energy solicitations is associated with the replacement of internal-combustion engine vehicles by EVs equipped with battery energy storage. This answer was understood in an ecological context for reducing air pollution and guarding overall biodiversity and the ecosystem, which are currently vital. The battery energy storage of such EVs will at last be charged wirelessly by IPTs in static and/or moving mode.

5.2.1 IPT Tool Arrangement

A wireless IPT tool is put in the middle of the source of power and the battery storage. The principal part of this tool, in charge of wireless power transmission, is an inductive coupler transformer (ICT) connected to each source and load via static converters using power electronics. The ICT consists of a transmitter and receiver coils, each with inductance L_1 or L_2 , separated by an airgap that characterizes the mutual inductance M_{12} . The airgap size results in a tenuous coupling between the coils, and consequently, the required power transmission involves substantial reactive power. Accordingly, the transmitter and receiver coils are compensated by capacities C_1 and C_2 . Therefore, an IPT tool can execute a galvanic wireless transfer and a capacitive compensation, allowing electronics linked to ICT to operate at resonance. The compensations on both coils of the ICT guarantee dependable efficiency [12, 29]. They may use diverse topological combinations (series S or parallel P) dependent on the load nature, such as for the two coils, SS, SP, PS, PP [29, 30]. The SS topology looks to be an economical selection [29, 31]. Sheets of magnetic ferrite are regularly used to cover the outer surfaces of the ICT coils, thereby improving power transmission efficiency, which is related to a higher coefficient of coupling. Figure 4 shows exemplifications of an IPT including its ICT specifics. The IPT comprises its ICT- ferrite sheets, introduced flanked by the grid and the battery. It is connected via a filtered AC-DC-AC frequency-voltage adjusted conversion to the grid and via a filtered AC-DC conversion to the battery [20].

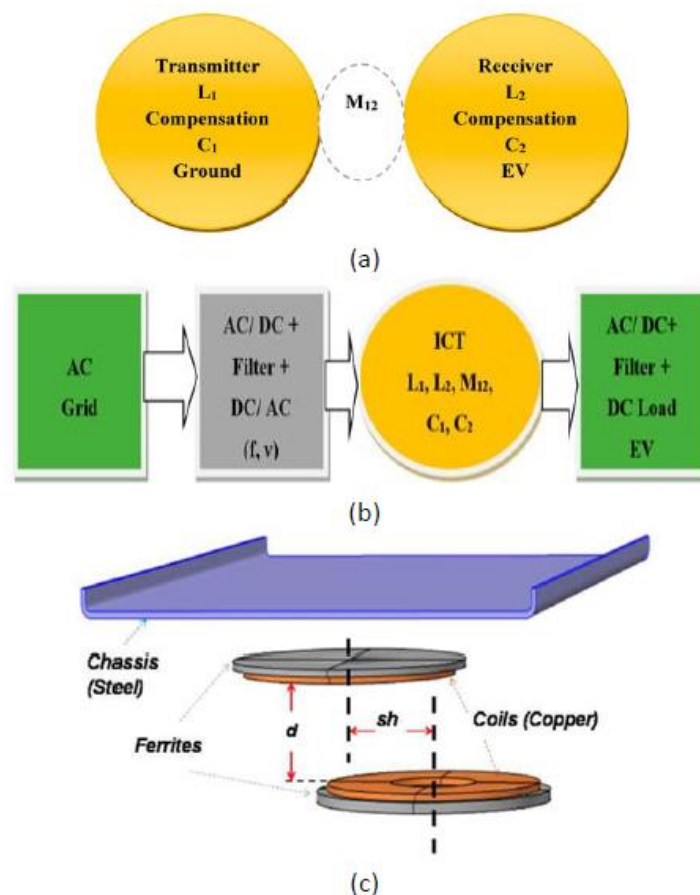


Figure 4 Exemplifications of IPT comprising ICT, (a) compensated ICT coils, (b) IPT components, (c) 3D ICT Structure with its two coils, ground transmitter, EV bottom receiver, alongside their magnetic ferrites, and a steel chassis plate [20].

5.2.2 IPT Sustainable Design and Control

The RA tactic related to sustainable design and control of an IPT concerns the characteristics and topological building of the ICT coils and ferrites, circuit compensations, filters, and static convertors. Consequently, shaping superior performance [29-31] across better coupling and dripped stray fields [20, 32] that manage the OH methodology; this illuminates the interaction of the AR and OH approaches. Moreover, these two methodologies are closely linked, along with the IPT design, to the charge state evaluation of the battery and system administration [33]. This last includes load (battery charging) scheduling control, which allows sustainability associated with clean energy usage and cost-effective rating; see, for instance [21]. In effect, EM energy, as stated previously, is reflected rigorously clean if it comes from the conversion of clean energy. Figure 5 shows the schematics of the sustainable design of an IPT in an urban background [20, 34].

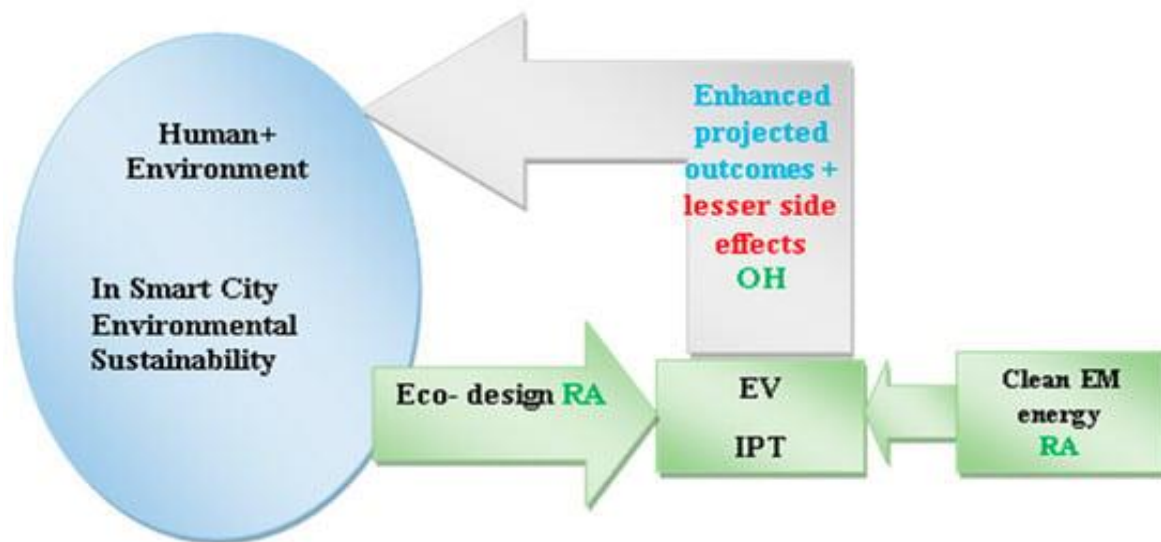


Figure 5 Sustainable design of an IPT and clean energy use taking into account all urban biodiversity [20, 34].

The ICT structure, summarized in Figure 4a, is given in Figure 4c. It comprises the ground transmitter, EV bottom receiver, as well as their magnetic ferrite plates. Furthermore, Figure 4c includes a steel plate representing the EV chassis. The coils of the ICT coupler with ferrites (pads) are separated by an air gap of (d) distance, and (sh) coil axes shift. Such a configuration reflects a coupling coefficient k and a resonant frequency ω_o (for example, coils with SS compensation) of the ICT, which are given by:

$$k = M_{12}(L_1 L_2)^{-1/2} \quad (8)$$

$$\omega_o = (L_1 C_1)^{-1/2} = (L_2 C_2)^{-1/2} \quad (9)$$

Such structure will be reflected in the design across equations (1-4) considering (8, 9) via (7) in a strong coupling of EM and electric circuits.

The living tissues BEs relative to induced fields and temperature growth could be obtained from the solution of EMF and BH equations, respectively (1-4) and (5), coupled through a heat source P_d

given by (6). The source term in the EMF equations corresponds to the stray field. The equations of EMF and BH will be weakly coupled.

5.2.3 IPT Batteries Charging and RA and OH Approaches

EVs - IPT wireless battery charging is a suitable option for common and self-sufficient EVs, buses, trams, ships, drones, etc., in an urban-friendly context. Such charging styles could be static, dynamic, mixed, disjointed, or fragmented static spots. A complete static manner relates to a specific, determined range and needs relatively great battery storage. A mixed static - dynamic way is typically appropriate to highways and requires modest battery storage. A disjointed direct grid-connected EV for a given trajectory with partly disconnected portions, which demands little energy storage and is suitable for public transport with road slices with challenging grid-connection infrastructures. The mode with fragmented distant static charging spots relays to buses using stops for charging with battery storage, depending on the number of stops, the distance between stops, and the static duration. All these charging styles necessitate security guards against EMF exposure.

RA and OH strategies aim for the diverse charging styles, fitting eco-designs, and clean energy usage, lessening of dangerous effects, risk assessment, and protection of biodiversity. Moreover, the energy administration between the EV and the grid might assist RA; thus, we can employ control processes for grid-to-vehicle (G2V) and vice versa (V2G) working approaches [35]. Furthermore, it is necessary to ensure interoperability of diverse IPTs (ground and vehicle ICT coils) [29, 36] and provide an appropriate charging profile permitting superior RA [37].

5.2.4 EMF Radiation, Charging Routines, and Safeguard

The EMF radiation owing to stray fields of ICT is strictly contingent on its two coils' 3D relative positions (ground to vehicle coils positions) and therefore strongly influenced by the charging manner (static or moving) and the vehicle space location. The stray fields in running charging routines are fluctuating contingent on the traveling position of the ICT receiver. In this circumstance, as well as that of buses with far-off static charging spots, the worried living tissues are those within the EV. In such circumstances, the passengers' protection might be attained by shielding the vehicle passenger compartment through ICT. Such a compartment in the situation of static charging routines is ordinarily empty, while for such a case, the affected living tissues are those situated near the EV, close to the ICT externally. In these conditions, the ICT 3D shielding is very complicated due to its arrangement. This problem is more challenging, for greater or more deformed air gaps conforming respectively to the expanses "d" or "sh" in Figure 4c. As such, these parameters are tough to handle, and consequently, any element being under or close to the EV bottom must be circumvented, particularly for a substantial period.

5.2.5 Control of Living Tissues BEs

The EMF exposure circumstances depicted before could be managed and certified by the solution of EMF equations (1-4), verifying living tissues induced field values corresponding to standard thresholds [38, 39]. For diverse charging routines, the aforementioned checking methods must comprehend the specific geometry and tissue properties. Assessment of living tissue EMF radiation requires methods of 3D computations to solve the EMF equations (1-4), including the ICT system

(Figure 4c) and the living tissue part (within or situated close to the vehicle). Numerical phantoms often signify such living tissues. The essential characteristics of such models are linked to the reliability of the physical-biological assets, the faithful shape, and the consistency with the numerical approach [34].

5.2.6 Case of Human Placed Close to an EV

An illustrative instance of ICT EMF radiation regarding the situation of a human body positioned on the ground horizontally next to an EV while static charging is presented in this section [34]. Figure 6 exhibits the induced field distributions (of B and E fields) in the body tissues owing to ICT exposure. The employed human body model for calculations refers to a high-resolution human structural model, well corresponding to the arithmetical 3D FEM used methodology. The induced B and E fields in the body tissues have been calculated from the solution of (1-4) with a source field consistent with the stray fields of an ICT (3 kW at 30 kHz). The results were compared to thresholds fixed by standards for safety [38, 39] ($27 \mu\text{T}$ for magnetic induction B and 4.05 V/m for the electric field E). In the present situation, outcomes were in conformity with such safety standards.

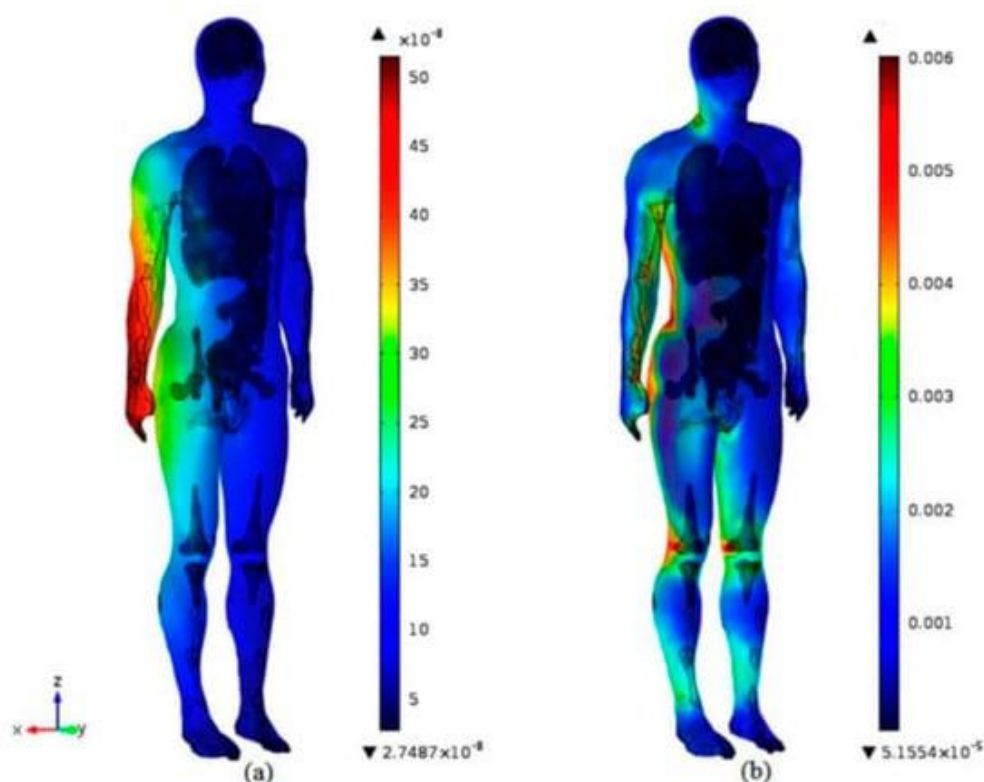


Figure 6 Field distribution in the body tissues exposed to an ICT (3 kW, 30 kHz) below an EV, for a horizontally positioned body alongside the EV. Magnitudes of: (a) B (T), (b) E (V/m), [34].

6. Discussion

In the analyses of the effects of wireless EMFs on living tissues in sustainable urban ecosystems discussed in the preceding sections, a number of points merit further discussion:

- The targets to strengthen the expected outcomes and lessen the unintended effects, thus enhancing device performance and biodiversity protection, could be accomplished, as abovementioned, through RA and OH approaches. It is interesting to note that often, the more advanced the device, the larger its unplanned effects will be. For instance, a further potent communication tool or a swifter battery-charging appliance would respectively engender greater radiated or stray fields. In such a circumstance, the task of RA and OH tactics would be more influential.
- In the paper analyses, the OH approach has frequently been stated. It emphasizes the interdependence of the different associates of biodiversity, “one for all and all for one,” for a reliable ecosystem where they subsist. The analyses have persisted on the point that human well-being should not produce troublesomeness to the associates of biodiversity, including humans. This is not a human donation towards biodiversity and the ecosystem; it is only a refund in favor of their activities helping the human being. It would be ample to mimic them, comparable to the deeds of pollinators (as bees) [40], hydrologists (as beavers) [41], etc., related to their ecosystem preservation activities. Other alliances in such a context are notable, for instance, the case of some viruses towards their host (virus–host dealings), thus offering their hosts the faculty to generate a poison permitting the destruction of their rivals (e.g., baker’s yeast action) [42]. Also, the interaction concerning bacteria and phytoplankton [43], or among some microorganisms, plants, and nutrient cycles [44].
- In appliances concerning the studied medical and mobility devices, sensors and actuators are often involved, and a wireless sensor and actuator network (WSAN) can be used, particularly in an intricate background. A WSAN is an assemblage of sensors that gather information at their positions, and actuators work together with them independently or are remotely controlled. WSANs are more and more exploited for healthcare (on-site or distant), ecosystem observing and control, mobility, smart cities, etc. [45, 46].
- Concerning connectivity in smart urban background [47-49], involving internal urban management, safety, education, etc., could allow for healthcare and mobility boards [50-52]. Distant supervising of such boards’ consistent data could be considered the present paper’s objective, “Management of wireless EMFs in sustainable urban ecosystems”.
- In the mobility application studied in the paper, it has been mentioned that the RA approach involves IPT sustainable design that depends on the figured and topological building of the coils of ICT, allowing better performance through enhanced coupling and lesser radiation via dropped stray fields. Many recent investigations are advanced in this topic related to ICT topology, see e.g. [53, 54].
- In the MRI-assisted robotic procedure, we used an MRI-compatible piezoelectric robotic actuator, reflecting the inverse effect of piezoelectricity (electric field producing deformation). It is worth noting that the direct impact of the piezoelectric material can be used in pressure sensors (deformation producing an electric field). These two effects are generally used for specific high-precision actions, actuation or sensing, and can be used in the same device, either one alternately [55].
- In the situation of battery IPT static charging style, the passenger compartment is ordinarily unoccupied. In contrast, for such a situation, living tissues, which can be humans (as in Figure 6), animals, birds, or plants situated exterior the EV in the neighborhood of the ICT placed under the bottom of the vehicle, might be disturbed by ICT stray fields. Such open space static

charging is frequently exercised for particular EVs at home, and distant spots of electric buses charging at their stops. As abovementioned, exposure security protections are indispensable concerning these open space static charging situations in urban ecosystems. Figure 7 exemplifies two examples of such menacing circumstances [20]. The conforming EMF radiation security safeguards are those related to the standard protection threshold [38, 39, 56, 57], designating the SAR level and exposure interval. As abovementioned, shielding against such EMF stray fields is unrealizable due to the configuration of ICT, thus protection from such radiation might be only done by using closed or encircled spaces. It should be noted that, in this context, the management of RA-OH approaches relates not only to manufacturers of devices but also to those having decision-making faculty relating to device use, namely adults and public authorities.

- The protection against EMF exposures can be accomplished in public healthcare centers, free parks, urban quarters, whole municipalities, woodlands, zoological spaces, botanical gardens, etc. [58]. Actually, the most significant disorders to biodiversity are generated by human-nature interactions. Preservation of biodiversity species, comprising humans, from EMF radiations might be achieved by three main strategies: shielding of emitting devices, decreasing their stray fields, and restricting their usage zones. Shielding of emitting devices is not evident since it is antagonistic to their functioning principle (high frequency wave scattering telecommunication) or unrealizable as mentioned in the last point (ICT). The lessening of their stray fields might partly reduce the risk, while the employed receiver tools would be impacted by truncated performance. Thus, the only manner to realize such a protection for biodiversity preservation is to reduce the device emission ability and hence performance, or restrict its usage. The choice of establishing areas without EMF emission might be achieved via constrained zones empty of radiating tools [59-61]. Such alternative protection focuses primarily on anthropogenic progress and its relation with biodiversity, thus deliberating the One Health concept [1, 2].
- The effects of EMF radiation on organisms, such as small plants, have also been explored. Those include flowering plants, vegetables, trees, nutritional (for humans and animals) plants, etc. Different works could be found, for example, in [62-66]. Also, general profits and dangers of such effects could be found in [67].
- Note that the involved living tissues in the upper analyses relate to inclusive biodiversity with irrigating tissues liquids, which can be blood for animals or sap for plants. The equivalence of phloem and xylem surrounding the sap in plants and veins and arteries, enclosing the blood in animals, is exemplified in Figure 8 [58].

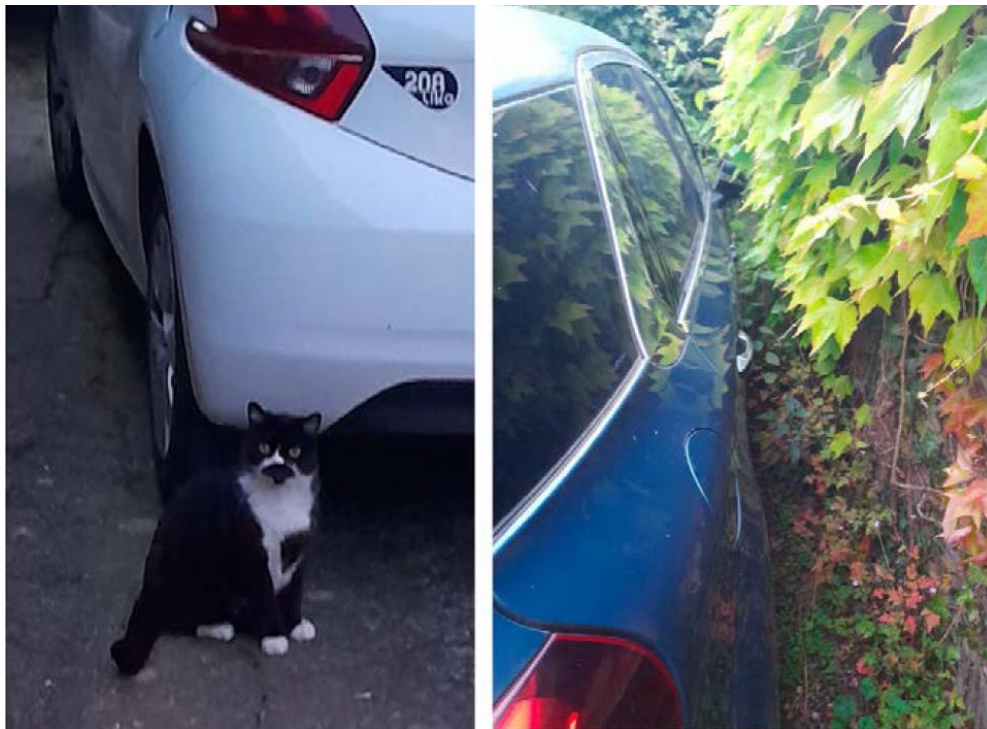


Figure 7 Illustrative examples of menacing situations for animals and plants situated close to ICT at the bottom of EVs [20].

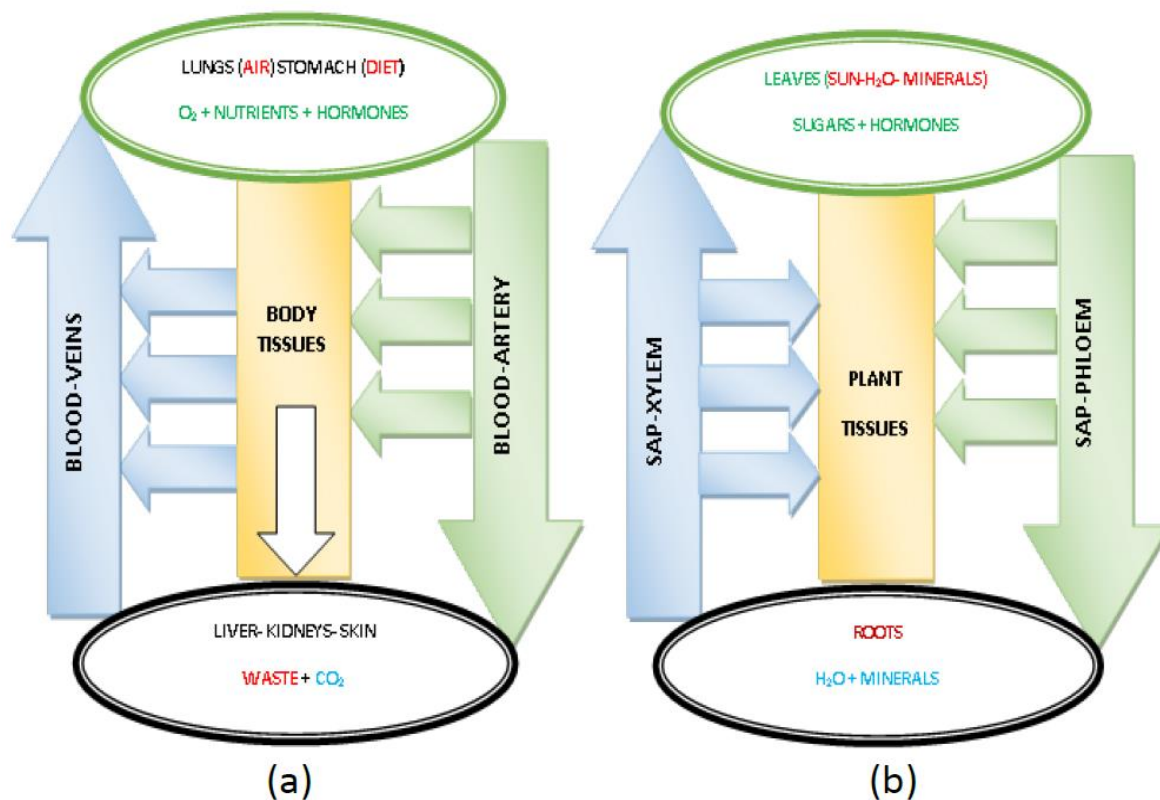


Figure 8 Demonstration of equivalence of veins and arteries, including the blood in animals (a) and phloem and xylems enfolding the sap in plants (b), [58].

7. Conclusions

The analyses performed in the present work have made it likely to underline specific concepts, permitting a deeper awareness of the matters allied to the vital role of RA and OH approaches in the management of EMF in the wireless tools concerned. Thus, the investigation and merging of these subjects are at the center of this paper. This management of RA-OH fears not only the designers and manufacturers of devices but also the users involved in biodiversity and having decision-making faculty relating to the modes of use, namely adults and public authorities. In conclusion, the urban use of wireless electromagnetic devices becomes perfectly coherent when their construction is compatible with the preservation of biodiversity and its ecosystem. These devices constitute one example among others of existing means that can serve humans while respecting their environment. It was time for responsible human behavior to match that of its partners in biodiversity.

The synthesis presented in this article is based on a review of existing literature, including the author's own work, illustrated by various results shown in the article's figures. The impact of the proposed approaches on biodiversity and its ecosystem will be more measurable in the more urbanized areas that are just beginning to emerge.

Author Contributions

The author did all the research work for this study.

Competing Interests

The authors have declared that no competing interests exist.

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