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Using ICT Tools for Exploring the Impact of Urban Blue-Green Spaces on Human Health and Well-Being

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Abstract
Worldwide, public health and well-being are significantly impacted by disruptions in physical, biological, and ecological systems stemming from urban environmental burdens. The H2020 project, "Healthier Cities through Blue-Green Regenerative Technologies: the HEART Approach," employs an innovative systemic methodology that integrates water (blue) and vegetated areas (green) infrastructure to address these challenges. The primary methodological approach of HEART clinical studies across three demonstration cities focuses on understanding how HEART project interventions relate to four chronic disease groups: cardiovascular, respiratory, mental, and metabolic conditions, with healthy participants as the control group. HEART study is using ICT tools as instruments in studying how blue-green spaces (BGS) impact public health and well-being in urban areas. 800 volunteers are equipped with smart-bands during their active time at demo sites in the cities of Belgrade, Athens and Aarhus. These wearable devices enable collection of biometric data, and project oriented mobile applications developed in collaboration between IT and medical experts guide participants on BGS visits, potentially monitor other health-related data and facilitate digital collection of socio-economic-medical questionnaires. Data collected from clinical measurements, laboratory tests, wearable devices, environmental sensors, and socio-economic-medical questionnaires will be analyzed using AI tools and statistical methods. These methods help to identify patterns and correlations between BGS visits and health outcomes. Overall, these ICT tools and methods are integral to the HEART project, enabling comprehensive data collection, real-time monitoring, and advanced analysis to evaluate the impact of BGS on public health and well-being in urban environments.

Keywords: Public health; Well-being; ICT tools; Chronic diseases; Blue-green spaces

Introduction

Globally, public health and well-being are affected by the disruptions of physical, biological, and ecological systems caused by the environmental burden in cities. The increase of non-communicable diseases morbidly and mortally has been recorded worldwide. The quantified negative impact of environmental pollution on health in the European Union resulted in 2021 with 253,000 deaths reported as attributed to exposure to fine particulate matter (PM2.5) above 5 μg/m^3, while 52,000 were attributed to nitrogen dioxide (NO_2) above 10 μg/m [1]. Additionally, short-term exposure to ozone (O3) above 70 μg/m^3 was attributed to 22,000 deaths. Concerning specific causes of mortality, exposure to increased PM2.5 attributed at first place to deaths from ischemic heart disease, while NO2 harmed diabetes mellitus [2]. Oppositely, the quantified positive impact of spending more than 30 minutes in blue-green spaces on human health in urban areas was less investigated and expressed in absolute numbers of people that directly benefited, but rather as lower odds ratios for a specific health outcomes such as depression or high blood pressure [3].

Public health and well-being are not standard urban planning criteria and are rarely integrated into that process, implicating the need for positioning citizens' health in the centre of urban planning and a good balance between social, environmental, and economic aspects [4]. Natural-based solutions (NBS) in urban areas should be designed in such a way as to enable healthy interaction between people and ecosystem services, which contributes to the improvement of public health and well-being. The relationship between urban planning and PH and WB enhancement is complex [5].

Based on the innovative systemic methodology of synergizing interactions of water (blue) and vegetated areas (green) infrastructure the H2020 project entitled Healthier Cities through Blue-Green Regenerative Technologies: the HEART Approach addresses these issues. Its principal aims are to significantly improve urban health and reduce health disparities by bringing nature to improve livability conditions and to alter the conventional approach to urban planning to focus on integrated nature-based solutions and concepts with emphasis on public health and citizens' well-being while considering sensitive societal and environmental aspects.

To achieve that the HEART Holistic Approach was built as a multidimensional framework consisting of four dimensions (individual health of study participants, blue-green solutions, environmental and community health) with the Health Centre Planning Matrix (HCPM tool) positioned in its centre.

Methodology

The main methodological approach to HEART clinical studies in all three demo cities was to understand the relationship of the HEART project interventions (recommendation) to four selected chronic diseases: cardiovascular, respiratory, mental and metabolic and healthy participants as the control group, assessing environmental (air quality, weather parameters, noise) distance to NBS, social, economic factors, as well as medical history of diseases and lifestyle factors. The HEART intervention/recommendation instructed participants in the following way: to perform 2-3 visits per week as a minimum, spend in the NBS/BGS at least 45 minutes to one hour and 15 minutes. Selected demo parks/locations with blue-green characteristics are in Belgrade (Serbia), Athens (Greece) and Aarhus (Denmark).

The goal is to engage 800 participants in all three counties until the end of the clinical study (December 2024). Recruited participants are randomly divided into study groups and their health will be monitored during the three-month study period, afterwards will be compared with those who suffer from the same diseases but without following instructions to visit the parks, just having their daily routine in the so-called grey areas (urban zones where they live and work).

Results

The ICT tools and methods play an important role in the HEART project by enabling comprehensive data collection, real-time monitoring, and advanced analytics to evaluate the impact of BGS on public health and well-being in urban settings.

ICT Tools Deployed

Mobile Applications: Medical experts were synergizing with IT experts to develop and test mobile applications tailored to fit the needs of each participant group. These applications are used to instruct participants on their visits to BGS, monitor health related data, track their emotional state, collect socio-economic-medical questionnaires digitally, and potentially monitor other health-related data.

Wearable Devices: Volunteers are equipped with 2 types of wearable devices (smart-bands), equipped with sensors to monitor various health metrics such as activity levels, heart rate, blood oxygen levels, stress levels, and emotional states. Beside the clinical measurements in the hospital setting, these devices are crucial in assessing the impact of BGS on participants' health.

Hospital data base: Specially designed for the clinical study within the HEART projects, Hospital data base enables each Hospital involved in the study to keep the study medical records and provide connection with project developed applications.

Environmental Sensors: Environmental in-situ sensors are deployed in demo sites to gather real-time data on environmental parameters like air quality, weather conditions, and other factors relevant to the study. These sensors help in understanding the environmental context in which participants are exposed during their visits to BGS.

Satellite Images: Satellite images are used as a tool to potentially gather spatial data related to the BGS and their surroundings. This data will be utilized to analyze vegetation coverage, urban heat island effects, or other relevant environmental factors affecting public health.

Methods for Evaluation

AI Tools and Statistical Methods: Data collected from various sources including clinical measurements, laboratory tests, wearable devices, environmental sensors, and socio-economic-medical questionnaires are analyzed using AI tools and standardized statistical methods. These tools help in correlating different datasets to identify patterns, trends, and correlations between BGS visits and health outcomes.

Digital Data Collection: Apart from wearable devices, hospital database and mobile applications, digital data collection methods include self-reporting through the HEART applications and digital filling of socio-economic-medical questionnaires. This ensures efficient data collection and management throughout the study respecting data privacy.

Conclusion and Actions

Robust datasets that will be obtained within the clinical studies in all three demo locations will undergo statistical and advanced statistical analysis, thriving to confirm defined hypotheses and answer research questions. Concerning selected diseases, the HEART investigators are interested in qualifying benefits for the group of participants who visited BGSs according to the instructions in comparison to those who did not follow the recommendation, specifically focusing on the status of the respective disease (before and after blue-green intervention) and existence and type of the correlation between defined clinical and environmental indicators. In addition to that, holistic validation will include social and economic aspects to better characterize observed results and potential impact on public health and well-being. Furthermore, obtained results from the HEART studies should help decision-makers and urban planners in building new or renovating existing blue-green areas in towns and cities.

Deployment of the all ICT tools used to reach the study goals, the HEART consortium highlights importance of the strong bonds between technology, health and environment.

List of Abbreviations: HEART- Healthier Cities through Blue-Green Regenerative Technologies; ICT- Information and communication technology; IT- Information technology; AI- Artificial intelligence; BGS- blue-green spaces; NBS- Natural-based solutions; PH- Public health; WB- Well-being; HCPM- Health Centre Planning Matrix.

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