Abstract

There is growing scientific recognition that physical activity and contact with urban green spaces have the potential to contribute positively to citizens’ health. However, many citizens are not familiar with the impact of urban environment on health and do not use the green spaces for physical activity or recreation. The achievement of healthier urban environments and healthy behaviour requires greater awareness and education of citizens on issues of environment and health. Citizens’ engagement in the research is an approach that develops and uses new technologies within local communities to collect and analyse data and to share knowledge. Active participation enables citizens to become more aware of how they can identify and tackle local ecological issues. In this paper, we report on the development of the project “Urban Design and Physical Activity: a Kaunas Pilot Study”, which is a part of the European Commission’s H2020-SwafS-2018 program project Citizen Science for Urban Environment and Health (CitieS-Health). The research model builds on Participatory Action Research. The study will be conducted through collaboration between community members, community-based organisations, public health agencies, and educational institutions with the aim of outlining the citizens’ concerns and placing them at the centre of environmental epidemiology research by developing a kit that engages the citizens and presents evidence on how the urban design and physical activity affect citizens’ health and well-being. This research will enhance the understanding of issues that affect community health. The participants will benefit from increasing knowledge and the promotion of changes in health-related behaviour.

Keywords: education and research, international project, citizen science.

1 INTRODUCTION

Over the last decade, there was a significant increase in the number of projects conducted by citizens. The majority of citizen science projects engage the participants in research design, data collection, and analysis of the questions about the neighbourhood environment. However, to date, citizen science has not relied heavily on the environmental impact on citizens’ health, and there are opportunities to engage those affected by environment-related health problems, such as respiratory diseases, allergies, cardiovascular, and other diseases. Epidemiological studies have shown that natural environment has specific beneficial effects such as improved mental health, reduced risks of cardiovascular disease, obesity, or diabetes, and lower risks for all-cause mortality [1], [2].

There is growing scientific evidence that both physical activity and contact with urban green spaces have the potential to contribute positively to citizens’ health [3]–[5]. Physical activity in green environment has been indicated as an effective tool to reduce physiological stress [6]–[8] and to improve mental health [9], [10]. Nature can also deliver a suite of physical, psychological, and social well-being benefits [11], [12], including a decreased risk of overweight [9], [12], [13] or cardiovascular disease [14]–[16]. The available evidence suggests that physical activity significantly correlates with the use of parks and residential land [17], and the availability of recreational spaces (such as parks) is associated with neighbourhood satisfaction, physical activity, a lesser risk of obesity, and better wellbeing [18]. Among the elderly urban residents, the prevalence of mental health issues such as stress levels and symptoms of depression generally decreased with an increasing ratio of green spaces in the residential area [19]. A Spanish study on adults found that increasing physical activity for 2 years after the age of 60 reduced the risk of cardiovascular disease-related mortality by 25%, whereas in individuals who maintained higher activity throughout this period, that risk was lower by 58% [20]. There is evidence that physical activity in natural environments is associated with a greater reduction in the risk of poor mental health and cardiovascular health problems than physical activity in urban street environment is [21], [22]. A recent USA cohort study found that maintaining physical activity from adolescence into later adulthood reduced the risk for all-cause mortality by 29% to 36%, while being inactive at a young age but increasing physical activity during midlife reduced such risk by 32% to 35% [23].
The current approach in environmental health research that relies on top-down techniques is insufficient for generating community-wide impact and inducing the uptake of the results in the society. There is a need for stimulating public participation and increasing awareness about such issues as the impact of physical activity on health and the connections between the quality of the surrounding urban environment, well-being, and chronic disease. The community-based participatory action research is a foundational method to engage those affected by environment-related health problems, and wider attention, education, and involvement of citizens in population health science are required. Citizen engagement in research is an approach that develops and uses new technologies within local communities to collect and analyse data and to share knowledge. Such research project-based learning involves the incorporation of a different role of both the citizen and the researcher within the learning-by-doing process. Active participation enables citizens to become more aware of how they can identify and tackle local ecological issues because their action provides them with "real-life" experience. Active citizens will acquire knowledge on participant engagement in the citizen science research, environment quality measurements and characterisation, project development and planning, progress tracking, and communication. Such project-based learning offers ways to transfer the acquisition of foundational and practical knowledge into "real projects for real citizens". A recent citizen engagement projects review concluded that the visions, methods, and experiences concerning community participation show that a participative approach may contribute to better, context-specific knowledge and health promotion, as knowledge stimulates health-related behaviour and suggestions for policy changes [24].

In this paper, we report on the development of the project "Urban Design and Physical Activity: a Kaunas Pilot Study", which is a part of the European Commission’s H2020-SwafS-2018 program project Citizen Science for Urban Environment and Health (CitieS-Health). The research model is built on participatory action research [25], [26]. The study will be conducted through collaboration between community members, community-based organisations, public health agencies, and educational institutions with the aim of outlining the citizens’ concerns and placing them at the centre of environmental epidemiology research by developing a kit that engages the citizens and presents evidence on how the urban design and physical activity affect citizens’ health and well-being.

### 2 METHODOLOGY

**Design of the Citizen Science Pilot Study.** The current concept used in this citizen science study has evolved over the past two decades [26]. The growing public involvement in the research significantly increases the need for innovative tools in database management, scientific analysis, and educational research. The model for developing this pilot study comprises 7 steps: choosing a scientific question; forming a team of scientists-educators; developing protocols, data forms, and educational support materials; engagement and training of the participants; data collection, coding, and display; data analysis and interpretation; and dissemination of the results and measurement of the outcomes. The main scientific objective of this pilot study is to assess how the urban design and physical activity affect citizens’ health and well-being. Specific objectives are the following: 1) Placing citizens’ concerns at the centre of environmental epidemiology research by developing a kit that engages the participants, gives answers to citizens’ questions, and provides them with personalised information. 2) Developing methods, tools, and maps that allow for easy scaling-up and replication of the citizen science project that lies at the intersection of epidemiology and citizen sensing, thus opening science to people from all backgrounds. 3) Evaluating the developed model and its impact on the society’s well-being and health. 4) Raising public awareness about the effects of urban planning and physical activity on health by translating scientific knowledge gained throughout the process into useful and practical knowledge for the society. This study engages adult permanent residents of Kaunas city of different age and social status, participants of previous studies and citizens in collaboration with neighbourhood associations, activist groups, and people concerned with the city’s environment and health problems. We engage the volunteers from communities through the Kaunas NGO Association that consists of more than 50 citizen entities in Kaunas, including the Civil Community Centre Dainava, Community Centre Aleksoitas, Community Centre Marvele, and Kaunas City Municipality Public Health Bureau, which are interested in collaboration in this study. Particular attention will be given to engaging people of different ages and socioeconomic status (students, employed, jobless, retired, and older people) to increase participation in citizen science of those people who are usually less represented in environmental epidemiological studies.

**Data collection and databases.** This CitieS-Health pilot study will use the available databases of previous environmental epidemiological studies for the characterisation of exposures at Kaunas city.
level, and will also employ basic personal-level data collection. The tools that are going to be used range from complex technical equipment to simple sensors. This pilot study concentrates on a tight connection between the organisation of local citizens to suggest environment and health questions and research employing lightweight technologies in the development of new knowledge and behaviour changes in environmental health. In this citizens-scientists collaborative study, the participants will suggest relevant topics for their own research in collaboration with the scientists. The potential areas of the study could be to identify Kaunas citizens’ major anxieties related to environmental problems, active mobility, city traffic, ambient air quality, greenness and other issues, and to reveal their expectations and needs for health support, which will give rise to social and policy implications. To collect new data, the questions suggested by the participants will be formalised by the scientists in the questionnaires, and tools will be suggested for the estimation of different environmental exposure (i.e., low-cost portable sensors and mobile apps). The scientists will familiarise the citizens with possible data collection techniques, means, tools, processing, and storage of new data that may be generated within the project. We will clarify which sources of environmental and health-related data best contribute to the expected outcomes of the study suggested by the citizens, and what data are available in Kaunas city from previous epidemiological studies. For this study, environmental exposure databases created in the EC FP7 ESCAPE and PHENOTYPE projects will be available. The already available environmental data sources include Kaunas city strategic noise maps; geographic information systems (GIS) databases with information on living surrounding, green space, street maps, air pollution, and others. Using the selected digital tools and data obtained from questionnaires and through sensors and remote monitoring, citizens and scientists will develop the final study design, and active participants will have the possibility to collect new data on environmental exposures and health effects during their everyday walking routes. In addition, with the help of digital tools, citizens will be able to study the risk factors of their chronic diseases and to learn from the aggregated data reports. From the beginning of the project, the participants will be involved in discussions to identify and prioritise environmental and health issues, and therefore we hope to obtain information about the full spectrum of problems and expectations that they might identify. Citizens will participate in all stages of the development of the pilot study: formulation of the research questions, designing and implementation of the study, and analysis, interpretation, and communication of the results.

**Work plan for the creation of the toolkit.** The study starts from the identification of citizens’ health and environmental concerns. Suggested questions for discussions: Does air pollution in your place of residence cause problems? Does noise interfere with your sleep, work, or rest at home? Can citizens easily walk and cycle around using good quality routes? How might the urban structures and the possibility for physical activity provided by them influence health-related quality of life and well-being? How may citizens’ behaviour and mode of mobility influence health and well-being? Does your physical activity reach the Public Health Guidelines for Physical Activity (150 min/week of moderate intensity activity, or 75 min/week of vigorous intensity activity)? How do you describe the current state of your health, mood, and physical activity? What related changes in urban design, or political decisions for healthy living and moving can we suggest? To assess active mobility in different environments, we will use GIS, maps, and sensors. In order to enhance the understanding of how urban design might affect physical activity (selection of walking and/or cycling routes), the participants will be familiarised with epidemiological research findings. After learning such methods as neighbourhood asset and risk mapping, the participants will acquire scientific skills to investigate the association between physical activity levels and self-rated health status. Active participants who will agree to wear FitBit Alta watch-pedometer will have a possibility to participate in tool development. We will create databases and tools based on health effects of physical activity in green environment and urban street environment. The databases and tools are planned to be used for formal and informal scientific education. We will evaluate the effectiveness of the created toolkit for the involvement of citizens in the research study and the measurement of environmental impact on health.

**Measurements.** For environmental exposure assessment, we suggest using the available Kaunas city traffic-related noise maps (Fig. 1), air pollution maps (Fig. 2), information on the quantity of greenness in the residential setting (i.e., the Normalised Difference Vegetation Index NDVI, Fig. 3), the residence distance to a Kaunas city parks (Fig. 4), and the frequency and duration of mobility in green and urban areas (a self-reported questionnaire). To assess citizens’ mobility, we seek to estimate the number of Kaunas citizens whose physical activity reaches the Public Health Guidelines for Physical Activity. National guidelines for aerobic physical activity recommend that adults should participate in at least 150 minutes of moderate intensity aerobic activity per week or 75 minutes of vigorous intensity activity per week, or an equivalent combination of both [27], [28]. Physical activity will be measured using the General Practice Physical Activity Questionnaire, physical activity sensors, and a smart watch. We will
use a self-reported health questionnaire and questions to obtain citizens’ opinion on the quality of the residential place and on the participants’ health. We will use geospatial analysis and statistical analysis software packages to assess the associations between environmental quality, exposures, physical activity, and the participants’ health and well-being.

![Figure 1 Kaunas city traffic-related noise map](image1)

![Figure 2 Kaunas city air pollution map](image2)

![Figure 3 Kaunas city Normalized Difference Vegetation Index (NDVI)](image3)

![Figure 4 Kaunas city parks layer](image4)

3 EXPECTED RESULTS

This CitieS-Health pilot study will bridge the gap between the citizen science and epidemiological studies in environmental health and will provide a means through which people may be engaged in the process of undertaking population health science research. The cooperation between scientists and the society and the use the technology-based tools for citizens’ participation as active citizen scientists in their own health studies can allow for personal data collection at a larger scale than traditional population studies would. We expect the study topics to include the participants’ anxieties relating city planning and environmental problems, their expectations and needs for health support and physical activity, their exposure to traffic flow emissions, and the effects of green spaces in neighbourhoods on health. We expect to measure the effects of walking on active participants’ health status. This study will fill the gap in the evaluation of the effects of traffic-related exposures on the well-being of citizens in different age and social status groups and will generate important new knowledge leading to area-specific estimation of health risk due to traffic-related exposure in the urban environment. The project will raise awareness about the effects of the quality of the surrounding environment on health and will increase the amount of scientific evidence on health benefits of physical activity in green environment. Potential new data generated in the course of the project and the benefits of the project include: i) Data on real-time...
physical activity in different environments and health-related data collected using low-cost portable sensors; ii) Data on environmental health problems in residential settings; iii) Increased public awareness of the effects of urban planning and physical activity; gained practical knowledge for the society; and iv) The acquired knowledge and data might provide citizens and stakeholders with evidence of health benefits associated with green city planning and physical activity.

4 CONCLUSIONS

Urban planning and green spaces are crucial for citizens' well-being and physical activity. The achievement of healthier urban environments and healthy behaviour requires greater awareness and education of citizens on issues of environment and health. The presented pilot study is an example of the use of citizen science in order to engage the public in environmental issues and education and to provide sound evidence for decision-making. The potential benefits of citizen science for population health science include understanding the complexity of the local public health problems, public awareness of and respect for well-being, and suggestions of health and policy interventions. This participatory approach of the CitieS-Health pilot study has a potential for a greater engagement of the society in knowledge production and use, the elucidation of the local environmental problems, tackling local ecological issues, and sharing knowledge. The collaborative research enhances the understanding of issues that affect the community’s health; the participants will benefit from increasing knowledge and the promotion of changes in health-related behaviour. The study will help the citizens acquire research skills, new knowledge, experience collaborating with scientists, and knowledge about healthy behaviour. The created toolkit on urban design and citizens’ physical activity will provide opportunities for new local and international collaborative research and policy recommendations.

REFERENCES


