Available online at www.sciencedirect.com

Public Health

journal homepage: www.elsevier.com/puhe

Original Research

Economic appraisal of the public control and prevention strategy against the 2010 West Nile Virus outbreak in Central Macedonia, Greece☆

A. Kolimenakis [a,*], K. Bithas [a], C. Richardson [a], D. Latinopoulos [b], A. Baka [c], A. Vakali [c], C. Hadjichristodoulou [d], S. Mourelatos [e], S. Kalaitzopoulou [e], S. Gewehr [e], A. Michaelakis [f], G. Koliopoulos [g]

[a] Institute of Urban Environment & Human Resources, Department of Economic and Regional Development, Panteion University, 14 Aristotelous St., GR-17671 Kallithea, Athens, Greece
[b] School of Spatial Planning and Development, Aristotle University of Thessaloniki, Greece
[c] Hellenic Center for Disease Control & Prevention, Athens, Greece
[d] Department of Hygiene and Epidemiology, University of Thessaly, Larisa, Greece
[e] Ecodevelopment SA, Thessaloniki, Greece
[f] Department of Entomology and Agricultural Zoology Benaki Phytopathological Institute, Athens, Greece
[g] Laboratory of Biological Control of Pesticides, Department of Pesticides Control & Phytopharmacy Benaki Phytopathological Institute, Athens, Greece

ARTICLE INFO

Article history:
Received 30 April 2015
Received in revised form
20 October 2015
Accepted 29 October 2015
Available online 19 December 2015

Keywords:
Cost benefit analysis
Economic appraisal of public strategies
Public health management
Socio-economic impacts of mosquito species

ABSTRACT

Objectives: The aim of the present paper is to evaluate the economic efficiency of the public control and prevention strategies to tackle the 2010 West Nile Virus (WNV) outbreak in the Region of Central Macedonia, Greece. Efficiency is examined on the basis of the public prevention costs incurred and their potential in justifying the costs arising from health and nuisance impacts in the succeeding years.
Study design: Economic appraisal of public health management interventions.
Methods: Prevention and control cost categories including control programmes, contingency planning and blood safety testing, are analyzed based on market prices. A separate cost of illness approach is conducted for the estimation of medical costs and productivity losses from 2010 to 2013 and for the calculation of averted health impacts. The averted mosquito nuisance costs to households are estimated on the basis of a contingent valuation study. Based on these findings, a limited cost-benefit analysis is employed in order to evaluate the economic efficiency of these strategies in 2010–2013.
Results: Results indicate that cost of illness and prevention costs fell significantly in the years following the 2010 outbreak, also as a result of the epidemic coming under control. According to the contingent valuation survey, the annual average willingness to pay to

☆ Part of this research has been co-financed by the European Union (EU Environmental Funding Programme LIFE+ Environment Policy and Governance) and Greek national funds through the LIFE CONOPS project 'Development & demonstration of management plans against – the climate change enhanced – invasive mosquitoes in S. Europe' (LIFE12 ENV/GR/000466). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.
* *Corresponding author*. Tel.: +30 210 92 48887, +30 6937195225 (mobile); fax: +30 210 92 48 781.
E-mail addresses: akolimenakis@gmail.com, akolimenakis@eesd.gr, uehr@panteion.gr (A. Kolimenakis).
http://dx.doi.org/10.1016/j.puhe.2015.10.023

eliminate the mosquito problem in the study area ranged between 22 and 27 € per household. Cost-benefit analysis indicates that the aggregate benefit of implementing the previous 3-year strategy creates a net socio-economic benefit in 2013. However the spread of the WNV epidemic and the overall socio-economic consequences, had the various costs not been employed, remain unpredictable and extremely difficult to calculate.

Conclusions: The application of a post epidemic strategy appears to be of utmost importance for public health safety. An updated well designed survey is needed for a more precise definition of the optimum prevention policies and levels and for the establishment of the various cost/benefit parameters.

Introduction

West Nile Virus (WNV) is one of the most widely distributed arboviruses in the world, with endemic foci in Africa, the Middle East, West Asia, North and Central America, and some parts of Europe and Australia. WNV is transmitted in a bird-mosquito cycle, and humans and horses are dead-end hosts only.[1] Most people infected with WNV show no symptoms and the infection therefore remains undetected. However, about 20% develop a mild disease, usually referred to as West Nile fever (WNF). In less than 1%, the virus causes a neuroinvasive disease (WNND) with serious neurological manifestations, i.e. encephalitis, meningitis, meningoencephalitis or acute flaccid paralysis.[2] The first recorded outbreak of WNV infection in Greece was in 2010, when 262 cases were identified. The administrative region principally affected was Central Macedonia (population 1.9 million), where 250 cases were recorded. WNND developed in 197 (75%) cases and 33 (17%) of these patients died.[2–4] The outbreak continued in the succeeding years with 100 cases recorded throughout Greece in 2011, 161 cases in 2012 and 86 in 2013. In Central Macedonia, during the transmission periods 2010, 2011 and 2012, the numbers of WNV infection cases were 31, 20 and 21, respectively. It should be noted that there is significant uncertainty as the WNV epidemiology is complex and no models have been developed that provide long-term predictions of how and where the various relevant factors will combine to produce outbreaks.[5]

The 2010 WNV outbreak was associated with the generation of certain costs related to prevention and control strategies, public health measures, health impacts and nuisance impacts. These costs were substantial, amounting to several million Euros, and it is consequently important to evaluate the economic efficiency of the strategies that were adopted. As WNV is a mosquito borne disease it is difficult to separate WNV control programmes separately from the other type of costs and benefits associated with the overall mosquito problem and the relevant control programmes.

In general, two main categories of costs may be assigned to the overall mosquito problem (see Fig. 1): a) public and private prevention costs; and b) socio-economic costs related to various health and nuisance impacts due to mosquitoes. The costs associated with the overall mosquito problem can be distinguished as direct and indirect costs. Direct costs are the most clearly defined, as they can be explicitly expressed in monetary values. Control and surveillance programmes, private expenditures and direct medical costs from mosquito borne diseases are the main types of direct costs. On the other hand, indirect costs are associated with various socio-economic impacts including the nuisance cost (that is, the impact of mosquitoes on the quality of life and working conditions) and morbidity costs from mosquito borne diseases (productivity losses). Indirect effects are often difficult to evaluate as it may not be easy to express them in monetary terms. Several specific methods have been suggested for their assessment, including contingent valuation methods, averting behaviour methods, morbidity cost estimates, and quality of adjusted life years.

An important issue related to the economic evaluation of the WNV prevention strategy is to determine the capacity of the control measures implemented in response to the outbreak (that is, the effect of public prevention costs) in reducing costs related to health impacts arising from the WNV outbreak as well as other side-effects such as the nuisance impacts arising from the overall problem of mosquitoes. This can be investigated through the implementation of specific economic analysis and tools, aiming to estimate the averted costs achieved possibly as a result of the implementation of the prevention and control programmes, that is, the costs that would have probably occurred in the absence of those programmes. As shown in Fig. 1, these reduced or avoided private prevention costs and socio-economic impacts can be considered as the potential social benefits of the preventive/control measures.

The aim of the present paper is to estimate the economic efficiency of the public control strategies as response to the 2010 WNV outbreak in Central Macedonia by conducting a cost-benefit analysis (CBA), on the basis of the impact costs averted in subsequent years. The aim and importance of economic efficiency in public health interventions is to identify the least cost alternative to meet a certain health objective (cost-effectiveness analysis) or to assess the net benefit of different intervention options (cost benefit analysis). A multi-objective assessment including both economic and non-economic indicators of performance might be also required to address certain problems. The application of CBA aims to contribute towards the economic appraisal of the net social welfare (socio-economic benefits minus socio-economic costs) from the implementation of public control and