

***Health risks from hazardous waste disposal: the need for international scientific cooperation***

***Rischi per la salute connessi allo smaltimento di rifiuti pericolosi: necessità della cooperazione scientifica internazionale***

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**Summary**

Adverse health effects due to waste management practices, and in particular of hazardous waste, potentially represent a public health issue in many less-developed regions and developing countries, because of growing waste production, inadequate waste management practices, lack of appropriate legislation and control systems, as well as of growing illegal hazardous waste transboundary movements driven by the most industrialized countries. According to the Report of the WHO Workshop held in Rome in 2007 “...the scientific literature on the health effects of landfills provides some indication of the association between residing near a landfill site and adverse health effects. The evidence, somewhat stronger for reproductive outcomes than for cancer, is not sufficient to establish the causality of the association. However a public health response is warranted”. Moreover, there is evidence and the global awareness of growing transboundary movements of hazardous waste from the most industrialized countries to less developed regions and developing countries. Export and import of

**Riassunto**

Gli effetti avversi per la salute causati da pratiche di gestione dei rifiuti, e in particolare di rifiuti pericolosi, rappresentano un problema di salute pubblica in molte regioni meno sviluppate e nei paesi in via di sviluppo a causa della crescente produzione di rifiuti e delle inadeguate pratiche di smaltimento, dell'assenza di appropriate normative e sistemi di controllo così come di crescenti movimenti transfrontalieri illegali di rifiuti pericolosi guidati dai paesi più industrializzati. Come riportato nel rapporto del Workshop dell'OMS (Roma, 2007) “...la letteratura scientifica sugli effetti sulla salute causati da interrimento di rifiuti fornisce alcune indicazioni dell'associazione tra risiedere vicino ai siti di interrimento e gli effetti avversi sulla salute. L'evidenza, talvolta più forte per la salute riproduttiva che per il cancro, non è sufficiente a stabilire la causalità dell'associazione. Tuttavia, ciò giustifica una risposta di salute pubblica”. Esiste inoltre un quadro di conoscenze e la consapevolezza, a livello globale, di un crescente traffico internazionale di rifiuti pericolosi dai paesi più indu-

Received/Pervenuto 21.5.2009 - Accepted/Accettato 17.7.2009

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hazardous wastes, as well as their regional final destination within a country, are driven by economic, political, environmental and technological factors such as differences in prices for treatments and disposal, different taxation levels for wastes, insufficient waste treatment capacity and technology, among several others. In this paper we aim to emphasize the need for developing international scientific cooperation activities in this field in the near future with the perspective to create an appropriate framework to promote studies, transfer of knowledge and technology as well as to widespread awareness on health risks from hazardous waste disposals. *Eur. J. Oncol.*, 14 (3), 151-159, 2009

**Key words:** hazardous waste, health impact, environmental justice, international cooperation

## Introduction

There exists increasing evidence of environmental exposures that are involving the health of populations worldwide. This fact points out that environmental health can be considered a key element within a development paradigm, which relies on the social determinants enabling populations to control their living and occupational conditions.

Environmental factors contribute to the global burden of disease and, in particular, they contribute to the growing incidence of non-transmissible diseases, like cancer, in the developing countries. Recent data demonstrate that more than half of cancer cases and 60% of deaths occur in developing countries, although there are striking variations of cancer patterns from region to region (1). Environmental factors are also related to occupational and environmental exposures to ascertained carcinogens as well as to environmental risks for which no scientific univocal evidence is so far available. In many developing countries, the lack of studies aimed to identify and quantify the exposure to environmental

rializzati ai paesi meno sviluppati o in via di sviluppo. L'esportazione e l'importazione di rifiuti pericolosi, così come la loro destinazione finale in una regione di un singolo paese, sono guidate da fattori economici, politici, ambientali e tecnologici come ad esempio differenze nel prezzo di trattamento e smaltimento dei rifiuti, differenti livelli di tassazione dei rifiuti, insufficiente capacità di trattamento e disponibilità tecnologica. Lo scopo di questo lavoro è evidenziare la necessità di sviluppare nel prossimo futuro la cooperazione scientifica internazionale in questo campo con la prospettiva di creare un contesto di lavoro appropriato a promuovere studi, trasferimento di conoscenze e tecnologia così come di diffondere consapevolezza sui rischi per la salute connessi allo smaltimento di rifiuti pericolosi. *Eur. J. Oncol.*, 14 (3), 151-159, 2009

**Parole chiave:** rifiuti pericolosi, impatto sulla salute, giustizia ambientale, cooperazione internazionale

risks in living and occupational environments, together with delays in implementing mortality and morbidity information systems, cause an underestimate of environmental diseases, in particular cancer occurrence (2, 3). In this regard, environmental epidemiology is required to promote studies on populations exposed to carcinogenic agents in less-developed countries, with the twofold aim to detect actual health risks and to set priorities for the adoption of remedial actions (3-5).

Adverse health effects due to waste management practices, in particular of hazardous waste, potentially represent a public health issue in many less-developed regions and developing countries, because of growing waste production, inadequate waste management practices, lack of appropriate legislation and control systems, as well as of growing illegal hazardous waste transboundary movements driven by the most industrialized countries, as documented by recent international and regional reports (6 and references therein, 7).

In this frame, the present paper discusses how international scientific cooperation may contribute

in providing tools for the improvement of control on the health impact of hazardous waste disposal, with special emphasis on contrasting transboundary migrations of these materials.

### **Hazardous waste disposal: evidence of adverse health effects**

The practice of dumping hazardous waste in ponds, quarries, agricultural soils and other inappropriate locations has characterized for a long time the industrialized countries, and is now being transferred to developing countries because of the progressive adoption of more stringent regulations in large parts of the world. This practice may both represent a clearly illegal procedure for waste disposal, or a rather primitive solution to the problem of waste management, that is now confined to countries or regions where good practices of waste disposal are not yet endorsed. In the industrialized countries, in past decades and presently in illegal practices, hazardous waste was also often conveyed to landfills intended for solid urban waste. It should be emphasized, in this respect, that the latter releases *per se* a number of chemical agents such as benzene, vinyl chloride, chlorinated solvents, polycyclic aromatic hydrocarbons and heavy metals, and that chemicals released by landfill sites may accumulate in soil, contaminate groundwater through leachate and also be dispersed in air, if soil and water protection are not adequately ensured by the landfill technology (8). As a consequence, most scientific studies on the health impact of landfill sites are not able to unravel the relative role of toxic waste and solid urban waste, especially when investigating long term health effects (9).

Notwithstanding these inherent difficulties, some evaluations of the evidence of the health risks associated with residence in the neighborhood of landfills have been made available by international and national scientific institutions.

According to the Report of a WHO workshop held in Rome in 2007, where a number of international specialists reviewed the existing epidemiological studies, "... the scientific literature on the health effects of landfills provides some indication of the association between residing near a landfill site and

adverse health effects. The evidence, somewhat stronger for reproductive outcomes than for cancer, is not sufficient to establish the causality of the association. However a public health response is warranted because a small but significant excess risk of several reproductive adverse outcomes, together with the large proportion of population potentially exposed to landfill, and the level of available evidence suggest that the potential health implications cannot be dismissed" (10).

A recent position paper of the Italian Association of Epidemiology on waste processing and health, based on a thorough review of the literature, reached consistent conclusions "... the considered studies detected a 10% excess risk of congenital malformations (in relation to landfills with conveyance of toxic substances), in particular defects of neural tube and cardiovascular system, gastroschisis and palatoschisis. Furthermore, multisite studies found an increased risk of low birth weight [relative risk (RR) ranging from 1.03 to 1.06] and of different types of tumours (leukemia, colon-rectum, lung, bladder, and liver cancers), with RRs between 1.02 and 1.20. Some studies, however, found no adverse pregnancy excess risks... In conclusion, as far as landfills with conveyance of toxic wastes are concerned, there is evidence of a small but statistically significant excess of congenital malformations and more consistent evidence of an increased risk of low birth weight. There is no convincing evidence of an increased risk of cancer, mainly due to incomplete residential histories and consequent problems to control for the latency period between the exposure and the disease" (9).

Following to these review documents, three major original contributions were published.

In England, Elliott et al (11) investigated the risk of congenital anomalies around 8804 landfill sites, including 607 where hazardous wastes were conveyed, with reference to the years 1983-98. The study took into account both spatial density and characteristics of the landfills; confounding from maternal age and socio-economic deprivation was controlled. For special waste sites, significant associations between the landfill exposure index and all anomalies, cardiovascular defects, hypospadias and epispadias were detected. Discussion of these findings was prompted by a comment of Vrijheid (12),

who stressed the need to develop more detailed monitoring of chemicals emitted by landfills, in order to pursue a specific exposure assessment and thus a valid estimate of the health impact of landfills. Elliott et al shared the view that improved data on landfill sites, waste types, volumes and emissions were required, together with a better understanding of the environmental fate of pollutants (13).

In the US, Gensburg et al (14) investigated the mortality experience of former Love Canal residents; this site, located in Niagara County (NY), came to attention in 1978, when it became clear that about 3000 subjects were currently resident in the neighbourhood of a landfill containing about 22,000 tons of over 200 chemicals including hexachlorocyclohexanes, benzylchlorides, organic sulfur compounds, chlorobenzenes and sodium sulfide/sulfhydrates. The cohort study included 6181 subjects who lived in Love Canal any time between 1940 and 1978; the follow-up covered the years 1979 through 1996. The observed mortality did not show major departures from expected figures based on Niagara County and New York State reference populations, with the exception of significant increases in acute myocardial infarction (AMI) and injuries. Mortality for AMI was especially increased among subjects resident in the subareas closest to the landfill and among those who had been exposed in childhood; the latter also showed an increased cancer mortality, but these figures were based on small numbers. Further epidemiological surveillance of this population is in progress.

The study on waste and health in Campania, the Italian region in which since the 1980s thousands of illegal and uncontrolled sites of urban, industrial and toxic waste disposal have been operating (whose first results had been presented at the 2005 Collegium Ramazzini Conference "Living in a Chemical World") (15), has been the object of two recent publications.

Fazzo et al (16) reported the cluster analysis of mortality and malformations in the 196 municipalities of the Provinces of Naples and Caserta, characterized by a widespread illegal practice of waste disposal, taking into account socio-economic deprivation. The study detected clusters of mortality for lung, liver, gastric, kidney and bladder cancer, and of prevalence at birth of total malformations and of

malformations of limb, cardiovascular and urogenital system. The clusters were mainly concentrated in a subarea where most of the illegal practice of dumping toxic waste had taken place.

Martuzzi et al (17) assessed the health effects of waste-related environmental exposures in these Provinces through a correlation study based on a waste exposure index that considered the potential hazard and the spatial density of 89 authorized and 138 illegal dumping sites (see Trinca et al. (18) for details on the index). The selected health outcomes were nine causes of cancer mortality (1994-2001) and prevalence at birth of twelve types of malformations (1996-2002). Data were adjusted for socio-economic deprivation. Statistically significant excess relative risks in high index compared to low index municipalities were found for all causes, all cancer and liver cancer mortality in both genders, stomach cancer and lung cancer in men, and for congenital anomalies of the internal urogenital system and of the central nervous system. Even if no firm conclusions can be drawn on the causal nature of these associations, because of the uncertainties in exposure assessment and the adopted ecological study design, the overall consistency of these findings supports an etiological role of waste-related exposures, and strengthens the urgent reclamation of contaminated areas together with the eradication of illegal toxic waste trafficking. It is concurrently recommended to further develop scientific research, with the adoption of protocols characterized by increasingly accurate procedures of exposure assessment, control of confounding and case ascertainment. The latter point is currently dealt with in the frame of a collaborative study with the Cancer Registry of "Naples 4" Local Health Authority (19).

### **International regulation on transboundary movement of hazardous waste and illegal practices of waste disposal**

The need for a global convention on transboundary movements of hazardous waste was raised a few decades ago, consequently to the progressive adoption of more stringent regulations on waste disposal in the most industrialized countries and to



the increasing problem of waste management illegally transferred to developing countries. The latter has been associated with the lack of national environmental policy or laws, the lack of adequate national monitoring systems on imported waste and appropriate control systems as well as to insufficient basic public health awareness on health implications of hazardous waste management and disposals.

To this end, the United Nations Environment Programme (UNEP) committed to prepare an international regulation taking into account the Organization for Economic Cooperation and Development (OECD) preliminary purpose to control transboundary movement of hazardous waste from the OECD Area to non-OECD countries. The OECD work led to the European Community Directive focused on the supervision and control of the transboundary shipment of hazardous waste adopted in 1984 (20). The UNEP final outcome was the adoption in 1989 of the Basel Convention for the control of transboundary movements of hazardous waste and their disposal (21) specially addressed to protect environment and population health from the adverse effects that may result from hazardous and other wastes. The Basel Convention entered into force in 1992.

In 1994, a relevant implementation of the Basel Convention was adopted at the second conference of the Parties (by 82 Parties present). The amendment, Decision II/12, consists in a full ban on the exports of hazardous waste from OECD countries to non-OECD countries (22). The ban amendment is not yet entered into force, although the ratification by 75% (62 Parties) of the Parties present to the time of adoption has been gained. Some of the Convention Parties support a different interpretation of the Article 17 (paragraph 5) of the Convention, concerning the amendment entered into force (23). The delay in entering into force of the Basel ban amendment, formally due to procedural aspects, highlights different misguided interests (mostly economic).

The present EU legislation on waste also includes the Basel ban amendment in a Regulation (2006) on the supervision and control of shipments of waste within, into and out of the European Community that prohibits the export of hazardous waste (any waste subject to the Basel Convention) to non-OECD countries (24).

Other regional agreements are of relevance in the global scenario of transboundary shipment of hazardous wastes. The Bamako Convention establishes the ban of the import into Africa and the control of transboundary movement and management of hazardous wastes within Africa. This convention was adopted by all African nations (except South Africa and Morocco) in Bamako, Mali, on January 1991, and entered into force in April 1998 (25). The IV Lomé Convention adopted in 1994 between African, Caribbean, Pacific Countries (ACP) and European Community (EC) recommend (article 39) the prohibition to all direct and indirect export of hazardous waste and radioactive waste to the ACP States (26). In 2001 the Waigani Convention entered into force. This Convention establishes the ban to the importation into Forum Island Countries of hazardous and radioactive wastes and the control of transboundary movement and management of hazardous wastes within the South Pacific Region (27).

There is evidence and a global awareness of growing transboundary movements of hazardous waste from the most industrialized countries to less developed regions and developing countries. For this reason several international and regional legislations have been addressed or include African countries; they are motivated by the huge hazardous waste flow directed toward this continent, which is affected by the severe occurrence of hazardous waste dumping mostly arriving from European countries (7, 28). Furthermore, transboundary movements of hazardous waste also affect the poorest Member States of the European Union as well as particular regions within a country, like Italy, where illegal transfer of hazardous waste presently occurs from northern to southern regions. Export and import of hazardous wastes, as well as their regional final destination within a country, are driven by economic, political, environmental and technological factors such as differences in prices for treatments and disposal, different taxation levels for wastes, insufficient waste treatment capacity and technology, among several others. Studies mainly performed in the US have demonstrated that the communities hosting dumping sites with presence of hazardous waste tend to be of lower socio-economic status and higher proportion of ethnic minorities than neighboring areas (29, 30).

The European Environment Agency (EEA) reports (7) that in 2005 Europe generated 66 million of tons of hazardous waste and that the shipped portion of notified waste from EU countries to other EU and non-EU countries resulted to be nearly 13% of the total hazardous waste generation. Furthermore EEA reports that, taking into account the considerable number of illegal shipments, severe implications for environment and human health are expected as well as an unaffordable economic burden for clean-up activities.

### **The need for international scientific cooperation on waste management and health**

Although health risks from hazardous waste disposal are a global problem involving both industrialized and developing countries and potentially representing a public health issue in many less-developed regions, scientific international cooperation on these topics is poorly developed or missing. There are several reasons that explain such a gap; the most likely is the difficulty to promote actions at international and local level capable to tackle the different and complex causative factors, which involve political, economic, and legal other than technological and scientific issues. The complex interactions affecting the hazardous waste disposal activities are described in recent national and international documentation (7, 31-33). Within its own action frame, the scientific international cooperation is demanded to deal with different and difficult topics such as the inadequate waste management practices and disposals, the lack of appropriate legislations and control systems, and the growing illegal hazardous waste transboundary movements driven by the most industrialized countries toward developing world.

As we have discussed in previous sections, the problem of health risks from hazardous waste disposal is assuming an increasing relevance and diffusion, and it has been transferred to developing world when and because it has not been solved in the most industrialized countries. This situation thus contributes to further increase the health risk transfer to developing countries also through illegal activities.

The scientific international cooperation on health risks from hazardous waste disposal has to face an unavoidable problem (the waste disposal) which, in peculiar local contexts, can assume amplified dimensions becoming an environmental and health emergency. In this context, the international cooperation can contribute to provide adequate tools for the improvement of control on waste management, promoting scientific research to implement appropriate control practices as well as the development of modern and innovative environmental monitoring systems at local and national level. Furthermore, the scientific international cooperation can contribute to dissemination and educational activities at different levels to overcome the insufficient awareness on health implications of hazardous waste management and disposal.

A peculiarity of scientific international cooperation on health risks from hazardous waste disposal is the possibility to simultaneously measure the environmental vulnerability and the health risk both in developing and industrialized countries. This might allow comparative studies that, accounting for the different socio-economic and epidemiological conditions, can contribute to the adoption of protocols characterized by increasingly accurate procedures of exposure assessment, control of confounding factors and of case ascertainment. At the same time, the adoption of a flexible working methodology, which assigns a particular attention to the different local cultural contexts, is required to facilitate the establishment of effective and useful relationships with the involved communities as well as local authorities and stakeholders both in developing and in the most industrialized countries.

In this paper we aim to emphasize the need for developing international scientific cooperation activities in this field in the next future with the perspective to create an appropriate framework to promote studies, transfer of knowledge and technology as well as to widespread awareness on health risks from hazardous waste disposals.

An interdisciplinary cooperation approach is in fact necessary to face the complexity of the involved topics (34). Socio-economic analysis, environmental studies, epidemiological and biomedical research, technical expertise and territorial knowledge of environmental and social organizations, represent multi-

disciplinary skills that are required to get fruitfully cooperation outcomes. An interdisciplinary cooperation approach is an appropriate tool to deal with the peculiarities and the specific aspects of the local contexts as well as to establish links with the national and international initiatives related to health risks from hazardous waste disposal. Environmental epidemiological research focused on the topics of concern should benefit from the knowledge of numerous relevant elements, such as: (i) the history of socio-economic development and the present situation of the study area (including industrial settlements, agriculture activities and land use, socio-environmental vulnerable communities or population subgroups living in the study areas and their exposure to environmental risk factors); (ii) the epidemiological national and local data on hazardous waste disposal potentially related-diseases; (iii) the availability of territorial health structures and access to their information flows; (iv) the presence of social and environmental organizations committed on these topics and capable to provide access to local information; (v) the existence of local investigations and practices on environmental conflict management; (vi) information on the occurrence of territorial illegal activities related to (hazardous) waste.

The scientific cooperation can contribute to the development or implementation of appropriate control practices also through the design of field and/or comparative studies focused on the distribution of harmful exposures and health effects of hazardous waste management and disposal. This concerns the identification of the most vulnerable communities or subgroups of population in the study areas in relation with environmental health deprivation.

Moreover, as far as the contribution to dissemination and training activities is concerned, the scientific cooperation is extremely important for:

- the promotion of thematic open access digital archives containing reference documentation, such as international conventions, regional legislation and national normative system on waste management and disposal and related issues; official reports concerning regional and international transboundary movements of hazardous wastes; the most advanced technical documentation and scientific studies on health impact of waste, particularly of hazardous waste-related exposures;
- the production of technical and scientific documentation resulting from the interdisciplinary approach joining multidisciplinary skills of cooperation partners addressed to the specific needs of the country or involved subarea (e.g. analysis of socio-economic implications of hazardous waste management and illegal disposals, methodological issues related to the identification, quantification and assessment of health effects of environmental exposures to waste disposal);
- dissemination, training and educational activities focused on both appropriate waste management and health implications of hazardous waste management and disposal, with particular attention to the results of local field studies performed within the cooperation framework. Activities addressed to different subjects (local communities and local and national policymakers) should be planned according to the local cultural context to better favor the increase of knowledge, awareness and capacity building on environment-health-waste issues.

All these activities (research, monitoring, control, dissemination and training) are required to account for a participatory methodology involving different subjects and stakeholders in order to strengthen their autonomy and capacity of control on waste related issues.

The establishment of an international scientific network for sharing knowledge, experience and scientific results in order to reduce the lack of control on public health issues (such as the hazardous waste disposal particularly affecting less-developed countries as well as illegal practices also affecting industrialized countries) can certainly represent a further contribution to promote scientific research and to create useful data bases and evidences to better assess the impact on health of hazardous waste management and disposal. This can enable public institutions as well as communities and populations to improve their control on environmental health, a social dimension of human development. All this represents an emerging challenge for the scientific community and the societies and therefore for scientific research at global scale.

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