

**ENVIRONMENTAL IMPACTS ON DIET, NUTRITION, PHYSICAL ACTIVITY AND  
CANCER PREVENTION IN LOW-INCOME, RURAL COMMUNITIES**

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## **ABSTRACT**

**Background:** In the United States and abroad, cancer is a major public health issue, with the incidence and mortality rates for most cancers increasing among individuals in low-income, rural communities. Diet, nutrition, physical activity, and cancer risk reduction in low-income, rural communities are influenced by numerous environmental factors, such as availability and accessibility of healthy foods, adequacy and quality of opportunities for exercise, and tobacco smoking.

**Objectives:** This paper: i) reviews and highlights the contribution of environmental risk factors on diet, nutrition, physical activity and cancer prevention; ii) provides case studies on how environmental measures have been used in community partnerships that sought to decrease cancer risk; iii) explore how environmental-level measures may be integrated to evaluate community initiatives targeting diet, nutrition and cancer risk reduction; and iv) give recommendations for research and practice regarding environmental risk, diet, nutrition physical activity and cancer prevention.

**Methods:** A combination of complementary strategies was used to collect information for the review including: a systematic review of scientific, government, and industry sources for information; computerized scientific literature databases; and reviewing government publications and databases through the Internet.

**Results:** Environmental risk factors for diet and nutrition in low-income communities include fewer supermarkets, more fast-food restaurants, and more corner stores. Low-income and/or ethnic minority individuals live in the worst ‘built’ environment, which limits participation in physical activity to a great extent. The lack of exercise in low-income populations might be attributed to environmental factors, such as unsafe neighborhoods and lack of recreational facilities. Targeted advertising is commonplace in low-income communities, and generally residents are confronted with a barrage of prompts that encourage unhealthy dietary practices, and other lifestyle behaviors making it extremely difficult to adopt and maintain the type of diet associated with lower cancer and disease risk. Tobacco smoke, alcohol consumption, indoor fumes from cooking, and radon are some of the potential environmental pollutants common in low-income communities.

**Conclusions:** Low-income, minority and rural communities bear an unequal burden from cancer death, and are often in environments, which promote cancer risks. Attributing the health impacts of environmental risk factors at community level on diet, nutrition, physical activity, and cancer risk reduction can serve several public health activities. It can help to prioritize actions for preventing or reducing cancer risk in communities, and it can inform planning for preventive action. It can also be a useful tool to identify high-risk communities, and predict health benefits that interventions will bring to these communities.

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## 1. INTRODUCTION

The environment includes all factors external to the organism that affect its health. Pertinent issues in the human environment include: food/water, energy, natural resources (soil, timber, minerals, water, air etc.), other humans (society, customs, religion, and government), disease (microbes, vectors, etc.), climate, waste minimization, and toxic substances (natural or human-made). Internationally, the environmental risks most commonly documented include salinity, deforestation, pollution, global warming, depletion of natural resources, loss of habitat and biological diversity, and decreased air, water and soil quality (Lea, 2005). Traditionally, environmental health scientists were either toxicologists or epidemiologists focusing on single pollutants such as pesticides, metals, solvents, asbestos or persistent organic pesticides (Frumkin, 2005). However, recently, environmental health science has expanded to include the entire array of external factors that may influence people's health (Frumkin, 2005; Hood, 2005). Over the past decade, substantial progress has been made in the evidence base that links environmental risks to health. Emerging literatures indicate that multiple environmental factors may influence community health on a daily basis, and in turn community health is strongly affected by its social, physical and cultural environment. Within this context, environmental health refers to protection against environmental factors that may adversely impact human health, or the ecological balances essential to long-term human health, and environmental quality, whether in the natural or human-made environment. Decisions about land use, zoning, and community design have implications for neighborhood access to healthy foods, and the level of safety and attractiveness of neighborhoods for activities such as walking and biking. The designated use, layout, and design of a community's physical structures and recreational resources affect behaviors, which, in turn, influence health. Therefore, it appears that the linkage between the environment and diet, nutrition, physical activity, and cancer prevention should be one of the key elements in the continued evolution of environmental health.

In the United States (US) and abroad, cancer is a major public health issue, with the incidence and mortality rates for most cancers increasing among individuals in low-income, rural communities. Cancer from all causes is the second leading cause of death in the US (ACS, 2003). Assessment of environmental risk factors in communities may be important in cancer prevention efforts. Diet, nutrition, physical activity, and cancer risk reduction in low-income, rural communities are influenced by numerous environmental factors, such as availability and accessibility of healthy foods, adequacy and quality of opportunities for exercise, tobacco smoking, ecological factors, occupational factors, water and water quality, media messages, social norms, sanitation and hygiene etc. (Crockett and Sims, 1995; Simons-Morton *et al.*, 1988). This paper: i) reviews and highlights the contribution of environmental risk factors on diet, nutrition, physical activity and cancer prevention; ii) provides case studies on how environmental measures have been used in community partnerships that sought to decrease cancer risk; iii) explore how environmental-level measures may be integrated to evaluate community initiatives targeting diet, nutrition and cancer risk reduction; and iv) give recommendations for research and practice regarding environmental risk, diet, nutrition physical activity and cancer prevention. A combination of complementary strategies was used to collect information for the review including: a systematic review of scientific, government, and industry sources for information; computerized scientific literature databases (for example, Medline, Social Science Citation Index, Science Direct etc.); and reviewing government publications and databases through the Internet (for example, statistical abstracts, census data etc.).

Attributing the health impacts of environmental risk factors at community level on diet, nutrition, physical activity, and cancer risk reduction can serve several public health activities. It can help to prioritize actions for preventing or reducing cancer risk in communities, and it can inform planning for preventive action. The review can also be useful in identifying high-risk communities, and predicting health benefits that interventions will bring to these communities. It can also improve the accuracy of linkages between health and the environment.

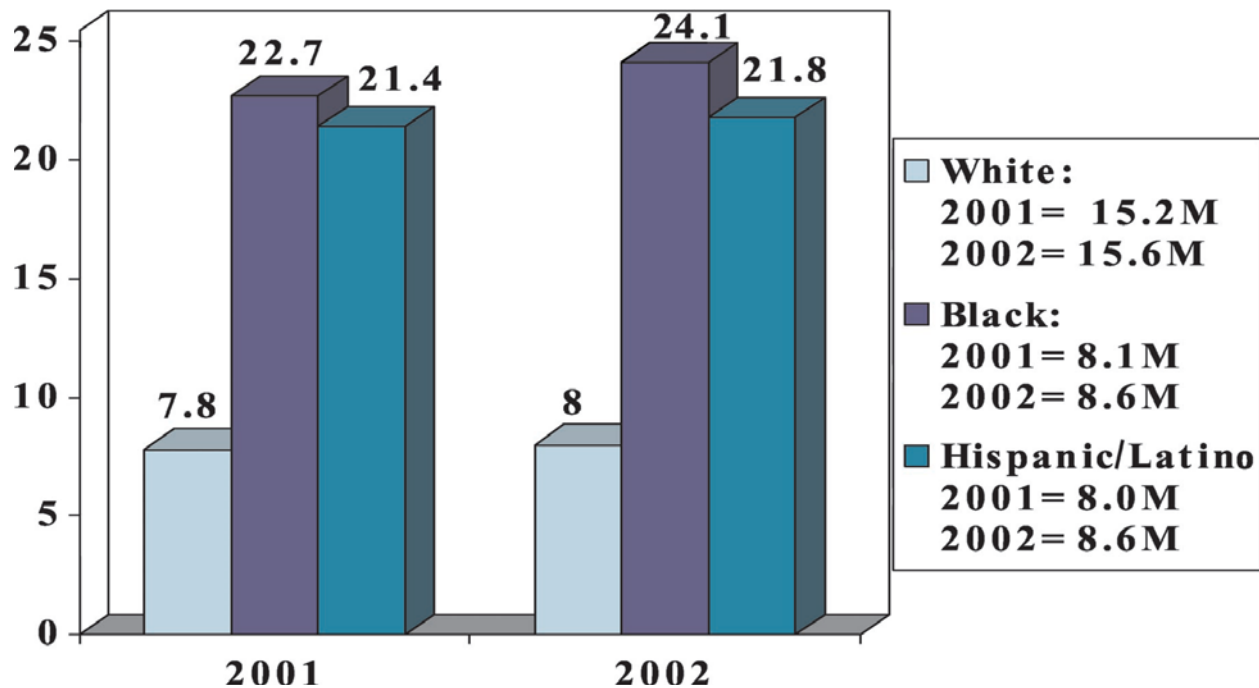
## **2. Environmental Risk Factors, Diet and Nutrition**

Low-income communities are characterized by lower than average annual household incomes (usually  $\leq 130\%$  of the poverty threshold), minimal education opportunities, predominantly minority populations, high unemployment rates, and disproportionate amounts of poor nutrition, and nutrition-related diseases (Figure 1). According to the US Census Bureau in 2002, of the 285 million Americans, 12% and 15% were poor and uninsured, respectively. In general, non-whites have higher rates of poverty, lower educational levels, and less access to health care than whites. Roughly 50%, 47.5%, 40.7% African Americans, American Indians, and Hispanics, respectively live in census tracts with poverty levels above 20%, compared with 7.0% whites (Singh *et al.*, 2003). Bal (1992) stated that being black statistically correlates with being relatively poor; less educated; and environmentally, behaviorally and socioculturally deprived. Table 1 shows the socioeconomic status, educational levels, and access to health care for ethnic groups in the US. Approximately 25% of the poor in America are African Americans (Proctor and Dalaker, 2003). The linkage between environment and diet, nutrition, low-income, rural communities, and the onset of nutrition-related diseases, such as cancer have long been recognized. Diet is a significant factor in the three leading causes of death in the United States (certain types of cancer, coronary disease and stroke). Frazão (1999) estimated that healthier diets could prevent \$71 billion annually in medical costs, lost productivity, and the value of premature deaths caused by just four diet-related diseases. Consumption of healthy foods is fundamental to the maintenance of optimal nutrition, cancer risk reduction, and other nutrition-related disease prevention. However, in most low-income communities, a variety of fresh fruits, vegetables and other foods are scarce, thus limiting availability and accessibility to healthy food choices.

There is accumulating evidence, which indicates that dietary choices are influenced by environmental factors, such as access to, and availability of healthy foods and food stores. For example, Cheadle *et al.* (1991) associated the availability of healthy foods in community grocery stores with healthy diets of the residents. Researchers found a positive association between fruit and vegetable intake, and number of supermarkets in African American neighborhoods. African and white Americans' fruit and vegetable intake increased by 32 and 11%, respectively, for each additional supermarket in the census tract (Morland *et al.*, 2002). Supermarkets, which are predominantly located in middle- and upper-income communities usually, sell a large variety of fresh fruits, vegetables, and other foods (Nayga and Weinberg, 1999). However, in low-income, rural communities, the absence of "chain" supermarkets is evident, and independently owned operations, which typically offer limited food choices, are more common. Cotterill and Franklin (1995) and Weinberg and Epstein (1996) revealed that there are fewer (20%) and smaller supermarkets in zip codes with above average numbers of low-income residents and high numbers of food assistance recipients. Similarly, Alwitt and Donley (1997) reported that poor zip codes in Chicago have fewer supermarkets than wealthier zip codes. Morland *et al.* (2002) found that there are four times more supermarkets located in wealthy neighborhoods compared

to low-income neighborhoods. Zenk *et al.* (2005) evaluated the spatial accessibility of large "chain" supermarkets in relation to neighborhood racial composition and poverty. Distance to the nearest supermarket was similar among the wealthiest neighborhoods, despite racial makeup. Among the poorest neighborhoods, those in which African Americans resided were, on average, 1.1 miles further from the nearest supermarket than those in which whites resided. Another study compared the availability and cost of diabetes-healthy foods in a racial/ethnic minority with those in a largely white affluent community. The findings demonstrated that only 18% of the low-income, minority neighborhood stores carried the recommended food items versus 58% in the affluent neighborhood (Horowitz *et al.*, 2004).

**Figure 1.** Poverty Rates by Race and Origin, 2001 to 2002 (Proctor and Dalaker, 2003)



**Table 1.** Socioeconomic Characteristics and Health Care Access of Different Ethnic Groups in the United States (US Census Bureau, 2000, 2001, 2003)

Ethnic Group	% with Income below Poverty Line	% Graduated High School	% <65y without Health Care Coverage
Whites	8.0	85.5	11.9
African American	24.1	72.3	19.2
Hispanic American	21.8	52.4	34.8
Indian	27.1	70.9	33.4
Asian	10.1	80.4	17.1

Block *et al.* (2004) examined the distribution of fast food restaurants relative to neighborhood sociodemographics in New Orleans, Louisiana, and found that fast-food restaurant density was independently correlated with median household income, and the percentage of black residents in the census tract. The researchers reported 2.4 and 1.5 fast-food restaurants per square mile in predominantly black, low-income and predominantly white neighborhoods, respectively. It is well known that regular fast-food consumption can lead to higher body mass index (BMI), which contributes to the development of some types of cancer (Thompson *et al.*, 2004; Jeffrey and French, 1998). This foregoing evidence presents a number of challenges in terms of diet quality, nutrition, and cancer prevention.

Low-income, rural communities are forced to depend on small stores with limited healthy food choices, and generally high prices because of inaccessibility to supermarkets (Curtis and McClellan, 1995). For example, food prices in small stores in Newark, New Jersey were as much as 38% higher than at suburban supermarkets (Bremner, 1990). It is not surprising then, that fresh fruits and vegetables are consumed less among low-income than high-income groups in many parts of the world (Wardle *et al.*, 2003). For example, in Britain, low-income groups consume one and a half times less fruit and vegetable than high-income groups, and similar associations have been observed in the US (James *et al.*, 1997; Serdula *et al.*, 1995). Further studies have shown that cost, which is a strong determinant of dietary choices impacts negatively on low-income groups because healthy foods are frequently unaffordable to them (Mackerras, 1997; Sooman *et al.*, 1993; Mooney, 1986). It has also been reported that food prices are higher for low-income groups because they purchase in smaller quantities, and rely more on processed foods (Curtis and McClellan, 1995). In addition, although most members of low-income communities receive resources from the federal government Food Assistance Programs to purchase food, the high prices they pay at the small stores reduce their purchasing power, making it difficult for them to obtain, or maintain the appropriate nutritious diet necessary for cancer prevention (Weinberg and Epstein, 1996).

Although food cost is an important risk, locality is another key environmental issue that interferes with low-income populations' ability to procure healthy food. It should be reiterated that disproportionate numbers of minorities live in low-income neighborhoods (Frumkin, 2005). In an older study, Sallis *et al.* (1986) compared supermarkets, neighborhood groceries, convenience stores, and health food stores in California. They reported that supermarkets had two and four times the average number of "heart healthy" foods compared to neighborhood and convenience stores, respectively. Morland *et al.* (2002) and Turrell (1996) showed that fewer households in low-income communities have access to private transportation, making it difficult for them to seek less expensive, healthy foods outside their communities. Nowak (1997) found that roughly 33% of low-income renter-occupied households do not own cars, thereby having limited geographic mobility and access to affordable, healthy food. Alwitt and Donley (1997) reported that low-income community members in Chicago have to travel between two, and three or more miles further than the rest of the city to reach areas with equal number of food outlets. The lack of supermarkets, high food cost, overabundance of highly processed foods (including fast foods), poor food quality, and limited private transportation in low-income communities are critical environmental factors, which contribute to disproportionate rates of poor nutrition and nutrition-related diseases (Lewis *et al.*, 2005). Consideration of the environmental risk factors that influence diet and nutrition in low-income communities is critical to effectively prevent cancer and other diet-related diseases in particular, and to improve health status of this population in general. In sum, the environmental risks factors for diet and nutrition in low-

income communities include fewer supermarkets, more fast-food restaurants, and more corner stores, which translate into limited opportunities for healthy eating (Block *et al.*, 2004; Morland *et al.*, 2002; Reidpath *et al.*, 2002).

### **3. Environmental Risk Factors and Physical Activity**

Physical inactivity, which is widespread throughout many low-income communities, and industrialized nations, is a major modifiable risk factor for many preventable diseases (USDHHS, 1996; Owen and Bauman, 1992; Sallis and Owen, 1999; Owen *et al.*, 2000). Physical inactivity and poor nutrition contribute to a host of other conditions such as cancer and heart disease, the two leading causes of death in the US (USDHHS, 2001). Additionally, poor nutrition and lack of appropriate physical activity are major causes of obesity and diabetes, which are considered national epidemics (<http://www.cdc.gov/nccdphp/dnpa/press/twinepid.htm>) The social and economic costs of these nutrition-related diseases are enormous; about 75% of the \$1.4 trillion US health care budget is directly linked to treatment of these conditions. There is sufficient evidence to draw a causal relation between physical activity and health outcomes, including reductions in the risk of mortality from all causes, reductions in some types of cancers, cardiovascular disease, and diabetes (TRB, 2005). Studies have also confirmed that endurance-type physical activity (for example, walking, cycling) also reduces the risk of developing obesity, osteoporosis, and depression (Saris *et al.* 2003; Landers and Arent 2001). Physical activity may also improve psychological well-being and quality of life (USDHHS, 1996).

On a national and international scale, health agencies have made recommendations for environmental change with limited understanding of the influence of environment on health behaviors (Sallis and Owen, 1996). The role of the environment in physical activity levels is a relatively new research area, and the evidence so far is limited, although it is continuing to experience some growth (Pikora *et al.*, 2002). Efforts to address physical inactivity levels in the US have mostly been guided by research focused on the individual, single setting (such as schools), and a single risk factor for chronic disease (for example, diet), while largely disregarding the environmental influence, whether natural or human-made (Richter *et al.*, 2000; Owen and Bauman, 1992). Efforts should be focused on identifying ways to: i) improve community environments, for example, community design, access to parks and safe public facilities; ii) increase accountability among government and industries involved in food systems, for example, use of public funds, sustainability, and marketing practices; and iii) encourage media responsibility to support healthy behaviors through changes in policy and organizational practices.

Although physical environments play an important role in influencing participation in physical activity, research indicates that the environment in low-income communities usually does not facilitate physical activity (King *et al.*, 1995). The term “built environment” is usually used to describe the elements of the physical environment, which are human-made, that is, in contrast to the natural environment (Ewing, 2005). The “built environment” includes: i) land use patterns (the spatial distribution of human activities); ii) the transportation system (the physical infrastructure and services that provide the spatial links or connectivity among activities; and iii) design features (the aesthetic, physical, and functional qualities of the built environment, such as the design of buildings in relation to land use patterns, and the transportation system) that together provide opportunities for travel and physical activity (TRB, 2005; Handy *et al.*, 2002). Social norms such as technology-based activities and pressures contributing to a fast-paced, on-the-run lifestyle are also environmental factors that impact negatively on physical activity.

The decision to become physically active is influenced by environmental (external) factors, that is, opportunities or restrictions that make the behavior easier or more difficult to perform; and inducements or deterrents, which encourage or discourage the desired behavior comparative to competing activities (TRB, 2005). The decision is also dependent on factors such as gender, age, ethnicity, education and income level (TRB, 2005). For example, Bal *et al.* (2001) found that infrastructure such as shops and walking paths within walking distance of the home is positively associated with increased levels of walking. Walking trails introduced into a low-income, rural community increased physical activity (Brownson *et al.*, 2000). Another study indicated environmental factors such as long distances, dangerous traffic, and crime as the main barriers to children walking and cycling more to school (Dellinger and Staunton, 2002). In a study, which examined the relationships between self-reported and geographic information system (GIS)-derived measures of the environment and physical activity, Duncan and Mummery (2005) found strong associations between the proximity of pathway networks and participation in recreational walking. They reported that having a footpath network further than 400 meters from the house was associated with a 69% reduction in the odds of participating in walking.

Researchers have consistently found that low-income groups do not exercise enough to benefit their health (Cauley *et al.*, 1991). The evidence suggests that physical activity interventions in low-income communities should focus more on addressing the influences of the physical environment. Macintyre *et al.* (1993) found an inequitable distribution of recreational facilities in favor of high-income communities. Estabrooks *et al.* (2003) compared accessibility to free structured physical activity facilities with census tracts, and found that low-income socioeconomic tracts had less accessibility, and lower numbers of physical activity facilities than high-income groups (4.5±2.3 versus 8.4±3.5). Ross (2000) reported that American residents from poorer suburbs had higher levels of walking for non-recreational activities, which was attributed to physical environment (higher neighborhood density). Giles-Corti and Donovan (2002) also reported that recreational walking was 21% less in low-income communities compared with walkers from high-income areas. In their paper, Badland and Schofield (2005) stated that the most pronounced urban design and transport differences exist around socioeconomic status. These findings are particularly worrisome because low-income groups are less likely to have disposable income, and are at higher risk for nutrition-related diseases, which are associated with physical inactivity (Badland and Schofield, 2005).

On the contrary, Giles-Corti and Donovan (2002) reported the unusual findings that except for golf courses and the beach, low-income communities in Australia, had equal or better access to recreational facilities compared with high-income communities. The study also reported that low-income residents were less likely to use recreational facilities that involved fees, except for swimming pools. Giles-Corti and Donovan (2002) concluded that social, normative or cultural factors might influence the use of the facilities in addition to access or economic status.

Some communities are poorly designed or unsafe, a particular obstacle for low-income residents who may feel especially vulnerable to crime or traffic. For example, communities with boarded-up housing are usually considered dangerous, and thus can generate fear among residents. Consequently, such neighborhood conditions might discourage residents from walking, exercising, or adopting other healthful behaviors that could otherwise protect them against cancer, and other chronic diseases. Figure 1 illustrates how the physical environment might influence health. In low-income communities, crime, disinvestment, and isolation can be major environmental risks, which deter many residents from physical activity such as walking

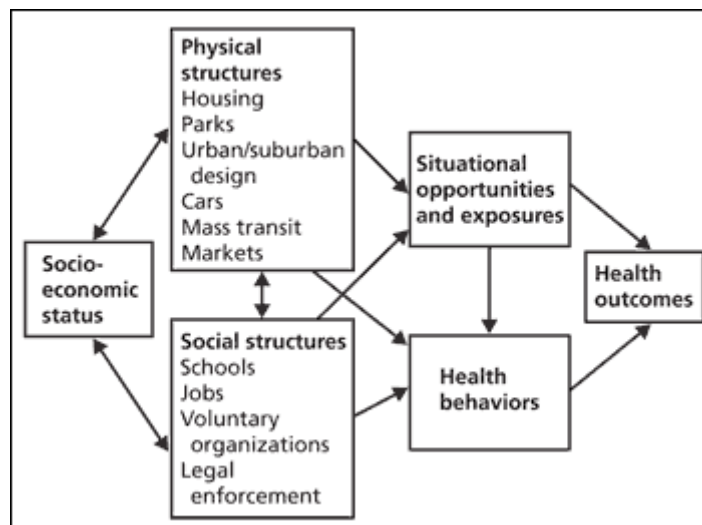
and cycling (TRB, 2005). However, it should be noted that not all low-income neighborhoods are affected by fears of crime. Perceptions of crime did not gain any significance in models used by Duncan and Mummery (2005) to measure psychosocial and environmental factors associated with physical activity. For the rural poor, however, isolation and long distances between destinations may limit walking and cycling more than crime and deteriorated neighborhoods (Brownson *et al.*; 2000).

To summarize, low-income and/or ethnic minority individuals live in the worst ‘built’ environment, which limits participation in physical activity to a great extent (Hood, 2005). The lack of exercise observed in low-income populations can be attributed to environmental factors, such as unsafe neighborhoods, lack of recreational facilities, poorly designed communities, isolation, and lack of financial resources to participate. The high level of physical inactivity among low-income residents increases their risk for cancer and other nutrition-related diseases.

#### 4. Environmental Factors Associated with Cancer Risk

Some populations, especially low-income, minority and rural populations bear an unequal burden from cancer death (Greene *et al.*, 1999). In these populations, which are often plagued with structural and institutional inequities, environmental factors also contribute to disproportionately high incidences of cancer (Aboelata *et al.*, 2004). For low-income communities, environmental hazards are among the main causes of ill-health, and premature death. This population also faces much larger environmental health burdens than middle or upper income groups. Low-income communities concentrate a wide range of environmental problems although their scale, importance and impact differ among communities. Table 2 gives an idea of the range of such problems, classified according to the nature of the problem, or the hazard it presents, and the physical context within which it occurs, such as the home or workplace.

**Figure 2.** How the Physical Environment Might Influence Health (Cohen *et al.*, 2000)



The figure illustrates how neighborhood conditions might affect residents’ health by inhibiting or facilitating risk-taking behavior, by influencing social relationships, and by exposing residents to visual cues that can arouse fear, anxiety, and depression

**Table 2.** The Range of City-related Environmental Problems by Context and by Nature of the Hazard or Problem (Satterthwaite, 2005)

<b>CONTEXT</b>	<b>NATURE OF HAZARD OR PROBLEM</b>	<b>SOME SPECIFIC EXAMPLES</b> (NB The list of examples is not intended to be comprehensive)
<b>Within house and its plot</b>	Biological pathogens	Water-borne, water-washed (or water-scarce), airborne, food borne, vector-borne including some water-related vectors (eg Aedes mosquitoes breeding in water containers where households lack reliable piped supplied). NB insufficient quantity of water may be as serious in terms of health impact as poor water quality. Quality of provision for sanitation also very important. Overcrowding/poor ventilation aiding transmission of infectious diseases.
	Chemical pollutants	Indoor air pollution from fires, stoves or heaters. Accidental poisoning from household chemicals. Occupational exposure for home workers.
	Physical hazards	Household accidents - burns and scalds, cuts, falls.....Physical hazards from home-based economic activities. Inadequate protection from rain, extreme temperatures etc.
<b>Neighborhood</b>	Biological pathogens	Pathogens in waste water, solid waste (if not removed from the site), local water bodies. Disease vectors eg malaria spreading Anopheles mosquitoes breeding in standing water or filariasis spreading Culex mosquitoes breeding in blocked drains, latrines or septic tanks. If sanitation is inadequate, many people will defecate on open sites - so lots of faecal contamination, including contamination of the sites where children play. If drainage is also inadequate, flooding will spread faecal contamination. If a settlement is served by communal standpipes, latrines and/or solid-waste collection points, these need intensive maintenance to keep them clean and functioning well.
	Chemical pollutants	Ambient air pollution from fires, stoves....; also perhaps from burning garbage if there is no regular garbage collection service. Air and water pollution and wastes from ‘cottage’ industries and from motor vehicles.
	Physical hazards	Site-related hazards e.g. housing on slopes with risks of landslides; sites regularly flooded, sites at risk from earthquakes. Traffic hazards. Noise. Health hazards to children if open sites have wastes dumped there because of no regular service to collect household wastes.
<b>Workplace</b>	Biological pathogens	Overcrowding/poor ventilation aiding transmission of infectious diseases
	Chemical pollutants	Toxic chemicals, dust etc.
	Physical hazards	Dangerous machinery, noise etc.

**Table 2.** Cont'd. The Range of City-related Environmental Problems by Context and by Nature of the Hazard or Problem (Satterthwaite, 2005)

<b>CONTEXT</b>	<b>NATURE OF HAZARD OR PROBLEM</b>	<b>SOME SPECIFIC EXAMPLES (NB The list of examples is not intended to be comprehensive)</b>
<b>City (or municipality within larger city)</b>	Biological pathogens	Quality and extent of provision for piped water, sanitation, drainage, solid waste collection, disease control and health care at city or municipal level a critical influence on extent of the problems
	Chemical pollutants	Ambient air pollution (mostly from industry and motor vehicles; motor vehicles' role generally growing); water pollution; hazardous wastes.
	Physical hazards	Traffic hazards. Violence. 'Natural' disasters and their 'unnaturally large' impact because of inadequate attention to prevention and mitigation.
	Citizen's access to land for housing	Important influence on housing quality directly and indirectly (e.g. through insecure tenure discouraging households investing in improved housing and discouraging water, electricity and other utilities from serving them).
	Heat island effect and thermal inversions	Raised temperatures a health risk, especially for vulnerable groups (e.g. elderly, very young). Air pollutants may become trapped, increasing their concentration and the length of people's exposure to them.
<b>City-region (or city periphery)</b>	Resource degradation	Soil erosion from poor watershed management or land development or clearance; deforestation; water pollution; ecological damage from acid precipitation and ozone plumes; loss of biodiversity from inadequate protection of important sites
	Land or water pollution from waste dumping	Pollution of land from dumping of conventional household, industrial and commercial solid wastes and toxic/hazardous wastes. Leaching of toxic chemicals from waste dumps into water. Contaminated industrial sites. Pollution of surface water and possibly groundwater from sewage and storm/surface runoff.
	Preemption or loss of resources	Freshwater for city preempting its use for agriculture; expansion of paved area over good quality agricultural land.
<b>Links between city and global issues</b>	Non-renewable resource use	Fossil fuel use; use of other mineral resources; loss of biodiversity; loss of non-renewable resources in urban waste streams.
	Non-renewable sink use	Persistent chemicals in urban waste streams; greenhouse gas emissions, stratospheric ozone depleting chemicals.
	Overuse of 'finite' renewable resources	Scale of consumption that is incompatible with global limits for soil, forests, freshwater etc.

In developed countries, cancer rates are disproportionately high in groups from poor socioeconomic backgrounds (Robertson, 2001; Faggiano *et al.*, 1997). Ward *et al.* (2004) concluded that for all cancer sites combined, residents of poorer counties have higher cancer death rates than residents in more affluent counties. Further, the researchers noted that within ethnic groups, those living in poorer counties have the lowest survival rates. An earlier report in 1986 report concluded that poor Americans, regardless of race, have a 10% to 15% lower five-year cancer survival (ACS, 1986). The key findings of a later report (Freeman, 1989) pointed out the following: i) poor people lack access to quality health care, and are more likely to die from cancer or other nutrition-related disease; ii) poor people face many barriers to obtain and use health insurance; and iii) cancer education and outreach efforts are insensitive and irrelevant to many poor people. Since that time, different reports have confirmed the association between low-income and increased risk of cancer. For example, lower screening rates, and lower detection of cancer continue to contribute to the high case-fatality rates among low-income women (Legler *et al.*, 2002). Although screening is widely recommended for colorectal, breast, cervix and prostate cancer; the proportion diagnosed at distant stage is higher in low-income than high-income census tracts (Singh *et al.*, 2003). It can be seen in Table 3 that among women diagnosed with breast cancer, the percent of localized stage diagnosis in low-income census tracts (59.0%) was lower than for those residing in wealthy census tracts (67.0%). Low-income minority women reported accessibility of services as a barrier to cancer screening. External factors such as cost of test, lack of transportation, insurance status, availability of affordable screening services, health provider availability, and inconvenient screening sites were cited as barriers to cancer screening (Ogedegbe *et al.*, 2005). In general, poverty, the main driving force of health disparities, is associated with lack of resources, information, and diminished access to health care (Freeman, 2004).

**Table 3.** Stage at diagnosis among cases with stage information by census tract poverty rate, 1995 to 1999 (Singh *et al.*, 2003)

	Area Poverty Rate <10%			Area Poverty Rate <20%		
	Localized (%)	Regional (%)	Distant (%)	Localized (%)	Regional (%)	Distant (%)
Lung						
Male	17.7	27.7	54.6	15.7	25.3	59.0
Female	21.5	26.5	52.0	18.8	24.4	56.8
Colorectal						
Male	43.2	37.8	19.0	40.0	36.3	23.7
Female	41.5	40.0	18.5	38.7	39.2	22.1
Prostate						
Male	95.2	_____	4.8	90.9	_____	9.1
Breast						
Female	67.0	28.0	5.0	59.0	32.4	8.6
Cervix						
Female	59.6	32.2	8.2	52.3	37.9	9.8

***Tobacco, Alcohol, Indoor fumes, Asbestos, Radon***

In addition to lacking the infrastructure to support physical activity, healthy eating, and access to health care, low-income persons have more exposures to environmental toxins than those with higher incomes. Also, low-income communities are more likely than high-income communities to be the sites of hazards, and contain substantial local sources of combustion-generated pollution (Aboelata *et al.*, 2004; Perera *et al.*, 2002). Tobacco smoke, alcohol consumption, indoor fumes from cooking, and radon are potential environmental pollutants (Cardenas *et al.*, 1997). Cigarette smoking has been definitively established as the dominant cause of lung cancer, which now accounts for 13% of new cancer cases, and 29% of all cancer deaths annually in the US (ACS, 2005). Overall, it is estimated that cigarette smoking is responsible for 85% to 90% of lung cancer deaths, and environmental tobacco smoke (ETS) accounts for an additional 3,000 lung deaths among non-smokers (Harmon *et al.*, 2004; CDC, 2000). It is estimated that there will be 73,020 deaths due to lung cancer among US women in 2005 (ACS, 2005). According to several researchers, ETS exposure is more prevalent among ethnic minorities than whites, and there is evidence that minorities are more susceptible to the chemicals in tobacco smoke (Pirkle *et al.*, 1996; Chen and Petitti, 1995; Wagenknecht *et al.*, 1993). For example, cotinine level was twice as high in African American children as in white children exposed to one cigarette per day (Knight *et al.*, 1996). Also, tobacco smoking is causally related to 16 types of cancer including cancers of the colon and rectum, oral, nasal, laryngeal, and esophageal cancer (International Agency for Research on Cancer, 2002; Wideroff and Schottenfeld, 1996). Among other types of tobacco use, such as snuff, cigars, and pipes, tobacco chewing is associated with increased risk of oropharyngeal cancer (Iyengar and Nair, 2000). Higher convenience store concentrations have been associated with increased levels of individual cigarette smoking in low-income communities (Hood, 2005). Additionally, advertising campaigns by the tobacco industry have been shown to target lower-income groups, making it difficult for them to give up smoking, which is such an important risk factor for the development of cancer (Davis, 1987).

Typically, individuals in lower socioeconomic groups consume more alcohol than individuals in higher socioeconomic groups (Brown *et al.*, 2001). These individuals also may have limited access to healthcare. Alcohol consumption is intimately linked with poverty, low-income and ill-health (Iyengar and Nair, 2000). According to (Brown *et al.*, 2001), the combination of four risk factors, namely, tobacco use, moderate/heavy alcohol consumption, low income, and infrequent consumption of raw fruits and vegetables accounts for almost all of the squamous cell esophageal cancers in the US, with low-income being the strongest risk factor. Their findings indicated that persons with incomes less than \$10,000 annually had a significantly higher risk for developing esophageal cancer than individuals with annual incomes of at least \$25,000. The risk was higher for low-income black men than it was for low-income white men. White men with annual incomes below \$10,000 were 4.3 times more likely to develop esophageal cancer than those earning more than \$25,000, whereas black men with annual incomes below \$10,000 were 8.0 times more likely to develop cancer than persons in higher income brackets. This increased risk persisted even with adjustments for alcohol and tobacco use and infrequent consumption of raw fruits and vegetables (Brown *et al.*, 2001).

In developing countries, burning coal or other smoke-producing fuel for cooking is associated with increased risk for lung cancer in women (Pauk *et al.*, 2005). Although fumes and vapors from cooking stoves are not normally a problem in developed nations, there is a unique situation of wood stove use in some rural communities in the US. Approximately 10 million wood stoves are currently in use in the US, with 80 to 90% being older stoves that emit

unacceptable levels of pollution. Seventy three percent of the individuals who purchase wood stoves reside in rural areas (<http://www.epa.gov>). Cooking with oil at high temperatures has also been associated with high levels of lung cancer among women (Du *et al.*, 1996).

Asbestos and radon are potential environmental hazards. Studies in humans have demonstrated that exposure to asbestos causes cancer. A dose-response relationship between asbestos exposure and lung cancer risk exists, and asbestos exposure is synergistic with smoking in increasing this risk ([www.meb.uni-bonn.de/cancer.gov/CDR0000062824.html](http://www.meb.uni-bonn.de/cancer.gov/CDR0000062824.html)). Radon, independently and increasingly with smoking, is an established lung cancer risk factor. According to the World Health Organization (WHO), radon, which originates from the soil, occurs naturally in the environment. Concentration of radon in the home is impacted by ventilation, condition of the home (cracks, openings etc), and quantities of radon present in the soil. Moderate exposures of radon can increase the risk of lung cancer in a smoker by 25 times. Uranium in the form of radon radioactive gas is responsible for six to 15% of all lung cancers, and is the second most important cause of the disease after smoking (WHO, 2005). Lubin *et al.* (1995) estimated that the lifetime relative risk for residing in a home at the Environmental Protection Agency action level of 4 picocuries radon per liter is about 1.4 for smokers and 2.0 for nonsmokers ([www.meb.uni-bonn.de/cancer.gov/CDR0000062824.html](http://www.meb.uni-bonn.de/cancer.gov/CDR0000062824.html)). These researchers also estimated that 10% of all lung cancer deaths and 30% of lung cancer deaths in never-smokers are attributable to indoor radon.

#### ***Helicobacter pylori and Nitrosamines***

Stomach cancer is another example of a tumor site, which is associated with poverty. Approximately 60% of all stomach cancers occur in developing countries (Johnson, 2004). *H. pylori* is a proven risk factor for gastric cancer (Johnson, 2004). In the development of stomach cancer, salt released from high-salt foods causes mucosal inflammation, favoring the impact of *Helicobacter pylori*. *H. pylori* cause mucosal lesions, which enhance the absorption of nitrosamine (Koifman and Koifman, 2003). Overcrowding, which is usually common in low-income communities, has been reported as one of the most important conditions associated with *H. pylori* infection, especially in young children (Goodman, 1997). Nitrosamine is a potential carcinogen, which is present in certain foods, or is produced following chemical transformation of N-nitroso compounds in foods containing nitrates and nitrites (Konrad, 1990). Nitrosamines may also be formed during food processing, and also by the colonic flora acting on digestive residues of meat protein (Bingham, 1999). The largest source of nitrites in the US diet is from cured meats such as bacon, sausage, lunchmeats etc. (Konrad, 1990). Salt has been used customarily as a food preservative added to meat, fish, vegetables, and other foods. Although there has been an increase in the use of domestic refrigerators as an alternative to pickling and salting to preserve food, high salt consumption is still common in low-income communities because of their reliance on processed foods and traditional eating habits. A case in point is the African American diet. The African American diet during the 1800s was highly reflective of fats, oils, sugars, fat salt pork, bacon grease, limited vegetables and nearly no fruits (Dirks and Duran, 2001). This type of diet was handed down, and is still reflected in present generations of African Americans, who make up the bulk of low-income communities, even though it is known that this type of diet contributes to various types of cancer development.

#### ***Pesticides and Other Chemicals***

Environmental factors play a major role in determining the risk of breast cancer, and the risk can be more than 10-fold (Coffey, 2001; Lichtenstein, 2000). McKelvey *et al.* (2004) studied the association between residence on Cape Cod and breast cancer, using residence as a

proxy for unidentified environmental risks. The authors concluded that longer residence on Cape Cod is associated with elevated breast cancer risk, and suspected environmental exposures included pesticides and drinking water. O’Leary *et al.* (2004) estimated historical environmental exposures to pesticides in stable female residents in Long Island, and associated these exposures to breast cancer risk. Increased breast cancer risk was seen for women residing closer to hazardous waste sites containing organochlorine pesticides. The authors concluded that further research is needed to clarify the association between exposure to pesticides and breast cancer. Other chemical exposures in and out of the workplace have been associated with a higher risk of breast cancer (Table 4). The potential environmental factors that impact upon breast cancer, may be largely preventable by modifying dietary practices, exercise and smoking (ACS, 2001), which is, for the most part, difficult for low-income populations. It is known that vegetables confer a protective effect on breast cancer. For example, a study with Swedish postmenopausal women demonstrated that the intake of cruciferous vegetables was inversely associated with breast cancer (Terry *et al.*, 2001). Despite this knowledge, vegetable intakes among low-income, minority women remain lower than for white women. Further research is needed to help clarify the relationship between the environmental factors and breast cancer development.

Rapid industrial growth has introduced environmental pollutants as a significant factor affecting cancer (Wang and Chen, 2001). Lead, chromium, cadmium, mercury, other heavy metals, and arsenic form the major group of pollutants generated by human activity (Iyengar and Nair, 2000). Lead, a metal found in natural deposits is ubiquitous in the environment. It is commonly used in household plumbing materials, water service lines, in cosmetics, ceramics, paints, soil, varnishes, lead-acid batteries, ammunition, fuel additives etc. The greatest exposure to lead is swallowing or breathing in lead paint chips and dust. The Environmental Protection Agency lists lead and lead compounds as “reasonably anticipated to be human carcinogens” because exposure is associated with small increased risk for lung or stomach cancer in humans (<http://www.epa.gov/woodstoves/changeout.html>). An Environmental Working Group (EWG, 1997) reported that analysis of air pollution data from 161 locations across California showed that residents of minority communities had a 54% chance of breathing unsafe levels of airborne lead compared with 19% chance for residents in predominantly white communities. Toxic particles such as nickel is released to the atmospheric environment from nickel mines, coal-burning industries and power plants, while chromium is released from coal- and oil-burning plants, and cement- and ferrochrome-producing industries (Gurjar *et al.*, 1996). There is increased risk for the development of lung and nasal cancers when exposed to chromium and nickel contamination in ambient air (Gurjar *et al.*, 1996).

**Table 4.** Examples of Chemical Exposures in the Workplace Associated with some Evidence of a Higher Breast Cancer Risk (Norman *et al.*, 1996)

ACID MISTS
Benzene
Carbon tetrachloride
Ethylene oxide
Formaldehyde
Lead oxide
Methylene Chloride
Styrene

### ***Diet and Food Resources***

Several lines of evidence suggest that environmental influences such as diet and lifestyle have been associated with different types of cancer. Some studies have indicated that 90% of all cancers are environmentally induced, 30 to 40% of these by diet (Prasad and Rama, 1985). As expected, households with higher incomes can choose the foods they prefer to eat, while low-income households are more likely to be concerned with price and value (Kronrdl and Lau, 1982). Research on the nutritional behavior and food resources of inner-city families has shown remarkable differences between food purchases made by low- and high-income households with respect to the total amount of cash and aid available for food (Emmons, 1986). For example, in 1992, households with mean incomes of US\$77311/y spent 2.6% for food compared with US\$6669/y (18.7%) spent by those in the bottom income (Kaufman *et al.*, 1997).

Usually, food industry markets products with high fat and sugar content to low-income communities (Robertson, 2001). Dietary habits, including high fat and low fruit and vegetable intake are among those associated with cancer risk. Low-income families tend to higher fat intakes and percent fat than high-income families (Marshall, 2000). Eyeler *et al.* (2004) found that among urban, low-income persons, education and income were associated with low-fat eating behaviors, fat calories, and frequency of fat/oils/sweets. Low-income populations tend to eat more processed foods because of poor access to food, and little choice in quality and variety (Robertson, 2001). Consumption of diets high in fat and red or processed meats can increase colorectal cancer risk (ACS, 2005). It is speculated that high fat intake may increase the levels of cytotoxic free fatty acids or secondary bile acids in the lumen of the large intestine (Key *et al.*, 2004). Dietary fiber from fruits and vegetables has been associated with reduced cancer risk, possibly acting by reducing bowel transit time and reducing the absorption of carcinogens by the colonic mucosa (La Vecchia, 2001; Gertig and Hunter, 1998). The low rates of colorectal cancer seen in Africa have been attributed to a high consumption of dietary fiber (Burkitt, 1969). Antioxidants in fruits and vegetables may also exert a protective effect. The role of diet and cancer prevention has been extensively discussed elsewhere (Johnson, 2004; Greenwald *et al.*, 2001; Shike, 1999; Konrad, 1990).

### ***Physical Activity***

Physical activity has been shown to have a protective effect on reducing the risk of colon, ovarian, endometrial and breast cancers (Cottreau *et al.*, 2000; Slattery *et al.*, 1997; Levi *et al.*, 1993; Shu *et al.*, 1993; Lee *et al.*, 1991; Slattery *et al.*, 1991). Physical activity patterns are possibly influenced by various ecological factors, including a supportive environment with accessible and affordable opportunities for regular physical activity (Crockett and Simms, 1995). In general, physical inactivity is about 43% in ethnic populations, especially African Americans and Mexican Americans (Taylor *et al.*, 1998). Women, ethnic minorities, older adults and people with lower socioeconomic status are among the least active in the US (USDHHS, 1996). Physical inactivity is higher among populations living in rural compared to urban areas (MMWR, 1998; Brownson, 2000; Wilcox *et al.*, 2000). Some of the more important environmental barriers individuals in low-income communities experience when trying to increase physical activity are: i) fees at physical activity centers; ii) fears about safety; iii) limited investment in parks and/or recreation facilities; iv) limited access to convenient facilities, and unsafe neighborhoods in which to be active (Kymanyika, 2002; Rimmer *et al.*, 2002).

Many targeted intervention programs to improve physical activity in low-income groups have presented disappointing results. According to French *et al.* (2001) and Swinburn *et al.* (1999), these failures have been increasingly attributed to a modern “obesogenic” environment

that promotes physical inactivity, and excessive food consumption. Environmental “obesogenicity” is especially concentrated in low-income, minority communities (Sloane *et al.*, 2003). The environment in low-income communities is conducive to physical inactivity and unhealthy food choices, which are associated with increased cancer risk. The environmental contribution to the high levels of obesity, which increases cancer risk among low-income individuals have been discussed elsewhere (Koplan and Dietz, 1999; Hill and Peters, 1998).

### **Targeted Media**

Targeted media advertisement to low-income communities is another environmental factor that may negatively influence their cancer risks. It has been demonstrated that significantly fewer advertisements for healthy foods in magazines and television shows target low-income, African American populations compared with those for general audiences (Lewis *et al.*, 2005). Additionally, a greater number of advertisements for unhealthy products such as sodas, and alcoholic beverages appear in magazines and television shows that target African Americans (Tirodkar and Jain, 2003; Pratt and Pratt, 1995). So far, there has been one litigation that settled a class action suit for advertising high-fat/high-sugar breakfast cereals with false claims of healthfulness to low-income, minority children (Hill and Peters, 1998). Lewis *et al.* (2005) examined the environmental prompts such as point-of-sale posters, and other print advertisements at restaurants that encourage the purchase of certain foods in south Los Angeles. The authors reported that restaurants heavily promoted unhealthy food options, and were less likely to promote healthy items than restaurants in a comparison area. They also concluded that low-income communities are confronted with a barrage of prompts that encourage unhealthy eating making it extremely difficult to adopt and maintain the type of diet associated with lower cancer and disease risk.

## **5. Case Studies**

The following case studies serve to highlight how environmental measures could be taken at both community and governmental levels to reduce cancer risk in low-income communities. The case studies have been reproduced from Aboelata *et al.* (2004). The measures have been taken at community level, but the problems the residents addressed are identical to the environmental risks discussed throughout the paper. The case studies will also be helpful to policy makers, public health officials, community activists, and public officials to examine possibilities for local environmental changes that would decrease cancer risk for residents of low-income communities.

### **Project 1. The Wray Health Initiative Builds Exercise Facilities and Makes Fitness Fun for People of all Ages (Aboelata *et al.* 2004)**

**Setting:** A group of citizens and health care providers called the Wray Health Initiative (WHI) became motivated to support resident participation in physical activity in the rural town of Wray, Colorado

**Environmental risk:** Lack of opportunities for physical activity.

**Method:** Donations and foundation grants, a multi-pronged community health outreach program that would create outdoor facilities, and help residents find the fun in fitness.

**Outcome:** Community-minded citizens built a 24,000 square foot, state-of-the-art rehabilitation center, which consisted of a walking track, an indoor swimming pool, nautilus equipment and free weights, a racquetball court, physical therapy equipment, and a hot tub and steam room. The building of a state-of-the-art recreation facility was necessary, but it also needed an infusion

of participants. With a special emphasis on heart health, WHI built recreation facilities, sponsored contests and hosted public events that would encourage regular exercise in a community context. Three years later, WHI reports significant community health improvements, including three times as many people participating in community-based walking programs and regular use of newly built indoor and outdoor fitness and recreation facilities. Although WHI is focused on heart health, the situation is applicable to cancer risk reduction. The venture can impact positively on many other health-related issues, from diabetes and asthma, to traffic safety and community violence.

**Project 2.** Partners through Food Increases Access to Healthy Food by Bringing a Full-Service Supermarket into the Community (Aboelata *et al.* 2004)

**Setting:** Upper Falls, Rochester New York.

**Environmental risk:** Fire destroyed the only grocery store in town and residents had no local access to affordable, fresh foods. After the fire, residents who wished to shop at supermarkets rather than high-priced, low-variety convenience stores were forced to travel long distances to outlying suburbs. Increased grocery shopping travel times and transportation costs burdened low-income residents, many of whom made their purchases with food stamps.

**Method:** Recognizing the injustice of living in a community with such limited food options, residents and activists collaborated with local government officials to lobby for a new supermarket.

**Outcome:** After five years of efforts and shifting strategies, the community group, Partners Through Food convinced TOPS, a major supermarket “chain,” to bring a shopping plaza and full-service supermarket to the neighborhood. The new shopping plaza opened in 1997, and since then residents say the retail area has transformed the neighborhood. Now they have easy access to affordable, healthy foods, which research suggests encourages healthier eating, as discussed before.

**Project 3.** South Los Angeles Liquor Store Closures (Aboelata *et al.* 2004)

**Setting:** South Los Angeles (LA) Community Coalition. The Community Coalition focuses its efforts in South LA, an area bounded by the Interstate 10 Freeway to the north, Highway 105 to the south, and between Alameda and La Brea Avenues to the east and west, respectively. The 820,000 residents (in an area that is around 71.3 square miles) are about 65% Latino and 35% African American. With a median annual income of \$21,000, the area is beset with a poverty rate that is two times higher than that of Los Angeles County, and three times higher than the national average.

**Environmental risk:** The community was oversaturated with alcohol outlets that negatively impacted on community health and safety.

**Method:** A newly formed group, the South Los Angeles (LA) Community Coalition, led a campaign to target liquor stores that detracted from community well-being and created public nuisances. Based on a large survey of residents, the group focused its efforts on identifying alcohol vendors with high rates of alcohol- and drug-related violence in, and around their businesses, and seeking closure of these community-unfriendly establishments.

**Outcome:** Community Coalition efforts to thwart violence and reduce substance abuse in an area oversaturated with alcohol outlets have achieved success by using a community-driven approach to reduce the number of neighborhood businesses that represent a threat to the health and well being of local residents. Prior to the Coalition’s work, the area had over 700 liquor stores, more

than the entire state of Rhode Island (population 1,048,319; area 1,045 square miles) or Pennsylvania (population 12,281,054; area 44,820 square miles).

**Project 4.** Evergreen Cemetery Jogging Path (Aboelata *et al.* 2004)

**Setting:** The Latino Urban Forum and Residents of Boyle Heights, California

**Environmental risk:** The city of map Boyle Heights, California showed only two kinds of open spaces: freeway on- and off-ramps and a cemetery with unsafe sidewalks for physical activity.

**Method:** The Latino Urban Forum helped the residents to transform a cracked sidewalk that ringed the Evergreen Cemetery into a 1.5-mile rubberized jogging path. The Evergreen Jogging Path Coalition (EJPC) worked intensively with city officials, emphasizing the need for capital improvements in the area, designing careful plans and securing materials.

**Outcome:** Six months later community organizers created a safe, pedestrian-friendly outdoor fitness area that promotes health by encouraging physical activity. The new path serves Boyle Heights residents and individuals from neighboring communities.

**Project 5.** San Diego's Environmental Health Coalition (EHC) (Hood, 2005)

This case study demonstrates how improvements to the 'built' environment can help to reduce cancer risk. It is cited from Hood (2005).

**Setting:** The EHC is a 25-year-old non-profit organization, which works in San Diego's low-income communities. It functions to help community organizations develop their capacity to document environmental hazards in substandard housing, and pursue effective organizing, and advocacy strategies for preventive and corrective actions.

**Environmental risk:** A low-income Latino community inundated with poor air quality due to heavy diesel truck traffic from a major regional freeway passing through the community, and a combination of industries and residences in close proximity to each other.

**Method:** The EHC convinced the California Air Resources Board to begin monitoring air quality in the community.

**Outcomes:** The outcomes included rerouting of the truck traffic to go around and not through the community (solving the problem of diesel exhaust). A metal-plating shop in the community was also forced to close because it emitted high levels of chromium-6, a highly toxic air pollutant. They are also working on changing land use and zones to lessen the number of industries that generate diesel truck traffic.

## **6. Summary and Recommendations**

The linkage between the environment and diet, nutrition, physical activity, and cancer prevention should be one of the key elements in the continued evolution of environmental health. The environment is an important element in understanding why low-income communities make poor food choices, are physically inactive, have poor lifestyle practices (high smoking and alcohol consumption), and are at higher risk than the general population for cancer development. Environmental risk factors for diet and nutrition in low-income communities include fewer supermarkets, more fast-food restaurants, and more corner stores which translate into limited opportunities for healthy eating. Low-income and/or ethnic minority individuals live in the worst 'built' environment, which limits participation in physical activity to a great extent. The lack of exercise observed in low-income populations can be attributed to environmental factors, such as unsafe neighborhoods, lack of recreational facilities, poorly designed communities, isolation, and lack of financial resources to participate. Low-income, minority and rural

populations bear an unequal burden from cancer death, and are often plagued with structural and institutional inequities, and environmental factors, which also contribute to disproportionately high incidences of cancer. The disparity in cancer is possibly due to a number of environmental issues, with poverty playing a dominant role.

Environmental hazards are among the main causes of ill-health, and premature death in low-income communities. Low-income persons have more exposures to environmental toxins than those with higher incomes, are exposed to more sources of combustion-generated pollution, and are more likely than high-income communities to be the sites of hazards. Tobacco smoke, alcohol consumption, indoor fumes from cooking, and radon are some of the potential environmental pollutants common in low-income communities. Targeted advertising is commonplace in low-income communities, and generally residents are confronted with a barrage of prompts that encourage unhealthy dietary practices and other lifestyle behaviors making it extremely difficult to adopt and maintain the type of diet associated with lower cancer and disease risk. The high level of physical inactivity among low-income residents increases their risk for cancer and other nutrition-related diseases. The review recognizes the need for further economic development in the low-income communities to improve availability and accessibility of healthy foods, to create opportunities for physical activity, and to reinforce positive lifestyle behaviors, for example, smoking cessation programs.

The continued evolution towards researching environmental factors as potentials for influencing diet, nutrition, physical activity and cancer risk reduction is promising. However, more research in this area is clearly needed. As suggested by French *et al.* (2001), the following environmental change research could target several areas including:

- Community organizations/action utilizing strategies such as community-wide task forces to change environmental conditions to support healthy eating and physical activity;
- Economic development to include “chain” supermarkets, which offer a variety of foods at affordable prices, and restaurants which promote healthy options;
- Media and advertising should be regulated to balance culturally sensitive, positive and negative media messages concerning food, physical activity, and cancer risk reduction education;
- Transportation and rural development to construct safe walkways and bicycle paths etc. in communities;
- Understanding of perceived and real environmental barriers for low-income groups;
- If low-income communities are to improve, broad, diverse participation is necessary, therefore, there is need for collaboration among community members, policy makers, and public officials in efforts to improve the environment;
- Improved health coverage, access and care for the uninsured and under-insured (Freeman, 2004);
- Targeted, culturally specific nutrition and cancer education; and
- Hopefully, diverse partners would come together and focus on environmental changes to reduce cancer risk among low-income groups.

In conclusion, there is need for increased awareness and concern about the short and long-term impacts of the environment on cancer risk, diet, nutrition and physical activity. In order to reduce the growing cancer risks attributable to the environment in low-income rural populations, it is essential that the environmental risk factors be ascertained through further research.

Together with more information on the costs of interventions, their effectiveness, and the socioeconomic context, data from such research will provide a rational basis for policy setting

(WHO, 2003). Furthermore, data on the environmental impact on diet, nutrition, physical activity and cancer prevention in low-income, rural communities can serve several public health functions. The data can be used to help prioritize actions for cancer prevention or risk reduction, help with the estimation of future cancer burden, and can inform planning for preventive action. The data can also be useful to predict health gains from interventions focused on environmental factors that pose a risk to health, and for identification of communities at high-risk for cancer. The data can also improve the accuracy of quantitative linkages between health and the environment, or improve the geographical applicability of data, or better describe the health impacts on low-income populations (WHO, 2003). Finally, and more generally, with the necessary research undertaken, the data can be used to raise awareness and strengthen institutional capacity for reducing the impact of environmental health risks on low-income populations.

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