Epidemiological Bulletin

Pan American Health Organization:
Celebrating 100 Years of Health

Vol. 25, No. 1 **March 2004**

Editorial

This year is the 25th anniversary of the Pan American Health Organization (PAHO) Epidemiological Bulletin (EB), which over this period has been continuously published, attempting always to report on diverse aspects of the most relevant information on the epidemiological and public health situation and activities in the Region of the Americas. The first issue of the EB was published in 1980 to disseminate relevant information on the practice of epidemiology, as a response to the changing needs of health services in the Region of the Americas, situation that is accentuated by the Health Sector Reforms initiated over the past decade and with the new demands arising from the steering role of the States, exercised through the Essential Public Health Functions. During the first years of its publication, the EB included articles on outbreaks or epidemic in the region, such as cholera, AIDS, dengue, among others, mainly communicable diseases. Today, these have a renewed importance with the appearance emergent and re-emergent diseases, including SARS, the West Nile Virus, Hanta virus, of which the EB has informed in their opportunity. With time, other topics like non-communicable diseases, mortality, accidents and environmental health were included, among others.

Given the potential and the dissemination capabilities of Internet, in 1998, the EB started to use this tool and published electronically, first in html formatting and two years later included the whole collection published in pdf formatting. With the electronic publication, the dissemination of the BE was multiplied, as the report on access statistics on EB pages in the PAHO Web from August 1998 to March 2003, indicates, when more than 626,000 queries, an average of 369 per day, occurred. Today, more than 135,000 consultations of EB pages reviewed. Responding to the demands of sectors of readers in the Region, the EB is published in English and Spanish and, selectively, in French.

In 1999, the EB was re-structured, publishing topics grouped into the following categories (numbers in parenthesis represent the percentages of published articles from each topic): situation and analysis of health problems (38%), analytical methodologies and information presentation (10%), public health norms and standards (37%) and relevant epidemiologic news (15%). Case definitions are included among the standards in epidemiology and represent 25% of all the queries to the EB Web page. In this regards, the EB has responded to the information needs in epidemiology of countries and the PAHO Secretariat.

In the future, the EB will maintain the publications lines established in the past, but emphasizing on the tools that warrant improvements in data quality, validity and consistency.

Given the relevance and needs of routine health information systems (HIS), another purpose of the EB will be to present strategies and work related to the Health Metrics network, activity that will help to strengthen the generation of (HIS) in the countries, aiming that the generated information follows the basic quality criteria including validity, reliability, comparability, transparency and ownership. Also, the EB will be seeking the decision-makers increase the use of such information to improve planning, monitoring and evaluation, all of which will improve the distribution of resources and direct health interventions. Achieving this, a more equitable access to information and services and better health will be reached.

Another future challenge for the EB is the monitoring of the Millennium Development Goals (MDGs). The international community has committed to the MDGs with a broader vision of development, that vigorously promotes human development as a key element to maintain the social and economic progress in all the countries and recognizes the need to create a world alliance for development. The MDGs have been accepted as a framework to measure the development progress and have 8 goals, 18 objectives and 48 indicators, that must be evaluated in several occasions until the year 2015. Of the total number of indicators, one third are related to the health sector, while others have a close relationship with health, being important determinants.

The EB will continue to give relevance and promote the use of core health indicators as tools for the characterization of the health situation and the planning of public health actions, paying special attention to the subnational levels (state or county levels) as the optimum situation required for health analyses. Likewise, the EB will support technical cooperation through publication of relevant health information related to PAHO key and priority countries. To complement this process, the EB will continue to promote the standardization of methodologies for collection, analysis and interpretation of health information.

IN THIS ISSUE . . .

Deaths from Motor Vehicle Traffic Accidents* in Selected Countries of the Americas, 1985-2001

Introduction

Deaths from road traffic injuries (RTI), and in particular Motor Vehicle Traffic Accidents (MVTA) have been characterized worldwide as a hidden epidemic which affects all sectors of society.[1,2] An estimated 1.26 million people worldwide died in 2000 from RTI, 90% of them in low and middle-income countries. In 2000, the road traffic injury mortality rate for the world was 20.8 per 100,000 population (30.8 in males, 11.0 in females). In the Americas, it was of 26.7 for males and 8.4 for females. The Americas bear 11% of the burden of road traffic injury mortality.[3] Globally ttraffic deaths and injuries on health and society have an enormous cost estimated around 1 - 2% of a country's GNP in lower income countries[2]. The theme for this year's World Health Day (WHD), celebrated on 7 April, was Road Safety when the growing problem of worldwide road traffic deaths and injuries were highlighted and a global initiative on road safety and road traffic injury prevention presented. The World Report on Road Traffic Injury Prevention[4], published on the occasion of WHD, presented a number of recommendations highlighted in Box 1.

In the Americas during 1997-2000, mortality from all land transport accidents was the tenth leading cause of death in the general population, the 6th leading cause in males with an annual average of registered deaths of 77,820 and the 16th in females, with 24,702 deaths[5]. The importance of the burden of death from land transport accidents, especially among younger age groups, is further noted in that they are the 2nd leading cause of potential years of life lost (YPLL) to 75 years of age overall (annual average of 4.2 million years) and in the male population (annual average of 3.2 million years) and 5th among females (annual average of 1.0 million years) over the same period.

The objective of this paper is to present a brief overview of the situation of MVTA in the Region of the Americas.

Methods

The full impact on the toll in human lives from motor vehicle accidents becomes clearer when annual data are studied. Registered deaths from MVTA were analyzed in 12 countries of the Americas during 1985-2001 – Argentina, Belize, Brazil, Canada, Chile, Colombia, Cuba, Guatemala, Mexico, Puerto Rico, United States and Venezuela. These countries were chosen for geographical and data availability reasons. During this period, mortality was classified according to the Ninth and Tenth Revisions of the International Classification of Diseases (ICD) in all of these countries with the exception of Guatemala where ICD-9 only was used.

Box 1: Recommendations from the World Report on Road Traffic Injury Prevention[4]

1) Identify a lead agency in government to guide the national road safety effort
2) Assess the problem, policies and iunstitutional settings relating to road traffic injury and the capacity for road traffic injury prevention in each country
3) Prepare a national road safety strategy and plan of action
4) Allocate financial and human resources to address the problem
5) Implement specific actions to prevent road traffic crashes, minimize injuries and their consequences and evaluate the impact of these actions
6) Support the development of national capacity and international cooperation

A motor vehicle is defined as any mechanically or electrically powered device not operated on rails, and includes cars, buses, trucks, vans, motorcycles, and off-road vehicles. A traffic accident is defined as any vehicle accident occurring on a public road or highway and includes vehicle accidents where the place of occurrence is unspecified. Non-traffic accidents are defined as occurring entirely in any other place than a public highway. Motor vehicle traffic accidents were assigned to categories E810-E819 in ICD-9 and to the following categories in ICD-10: V02-V04 (.1-.9), V09.2, V09.3, V12-V14 (.3-.6), V19 (.4-.6), V20-V28 (.3-.9), V29-V78 (.4-.9), V80 (.3-.5), V81.1, V82.1, V83-V86 (.0-.3), V87 (.0-.8), V89.2 and V89.9. In ICD-10, deaths from transport accidents are assigned according to the type of vehicle in which the victim was an occupant and then to the characteristics of the injured person – car or bus occupants, pedestrian, motorcycle rider, pedal cyclist and whether the accident was traffic or non-traffic. In ICD-9, however, the deaths were classified by the type of vehicle involved in the accident – train, motor vehicle, watercraft, and aircraft and whether the accident was traffic or non-traffic and then identifying the injured person. Also, in ICD-10, the death must clearly indicate that a "motor" vehicle was involved, whereas in ICD-9, the term "motor" did not have to be specified. Accidents involving unspecified vehicles or where the victim's mode of transport in ICD-10 is unknown are classified to "Other land transport accidents". It should be noted that deaths assigned to cause categories X59 in ICD-10 and to E887 and E928 may include "unspecified" deaths involving motor vehicles and were not

* The term "accident" is used in this article because the data presented specifically refers to codes used in the ICD and to the category titles used in the ICD 9 and 10 manuals. The distinction the ICD is making is that these deaths are not intentional and are accidental.

specified on the death certificate. As a result of the coding changes in ICD-10, caution should be observed when comparing mortality assigned to MVTA in both revisions. When available, comparability ratios between ICD-9 and ICD-10 for MVTA should be used to help interpret the data.

To analyze the data, proportionate mortality ratios and mortality rates were used. Analyses were carried out by age and sex. Death rates were also standardized by the direct method to allow comparisons between countries and periods.

Trends

Magnitude of the problem

In the selected countries, motor vehicle traffic accidents were the leading cause of death in females from 5-14, 15-24, and 25-44 years of age accounting for 15%, 18% and 7%, respectively, of all deaths from defined causes. They were also the leading cause among males 5-14 years of age (19%) and the second leading cause of deaths in males 15-24 (19%), and 25-44 years of age (12%). Of the registered deaths from **all** external causes 1985-2001 in these 12 countries, MVTA represents an average of around 20-30% in Brazil, Belize, Canada, Mexico, Puerto Rico, and the United States, 32% in Venezuela and 6% in Guatemala. Of the motor vehicle traffic accident deaths registered 1996-2001, pedestrians account for 12% in Argentina, Canada and the United States, 20-30% in Colombia, Cuba, Mexico, Puerto Rico, and Venezuela, and 30% or more in Brazil and Chile. These proportions appear to underestimate the actual toll of pedestrian deaths because in most countries 30-50% of MVTA deaths were assigned to "unspecified" categories, where the victim's mode of transport was unknown or the type of vehicle was unspecified. However, studies in Mexico and Colombia indicate that pedestrians are the most vulnerable road users especially in main urban areas such as Mexico City (54% of traffic deaths, 1994-1995), Bogotá, Medellin and Cali (32% of injuries, 40% of traffic deaths overall and 68% of fatalities in Bogotá, 1996-

Figure 1: Trends of MVTA in Brazil, Guatemala, Chile, and Mexico, 1985-2001

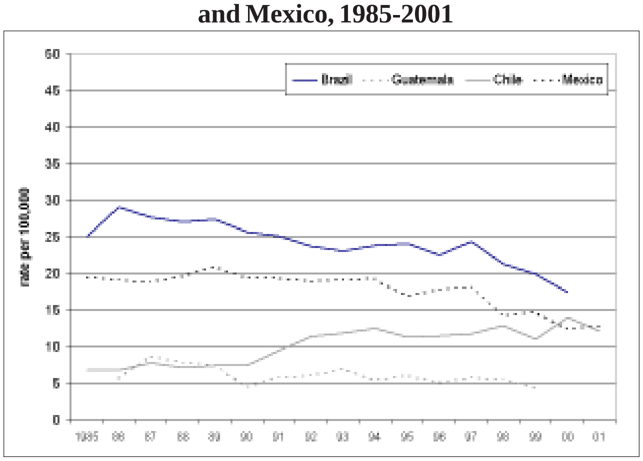


Figure 2: Trends of MVTA in Argentina, Colombia, Venezuela, and Puerto Rico, 1985-2001

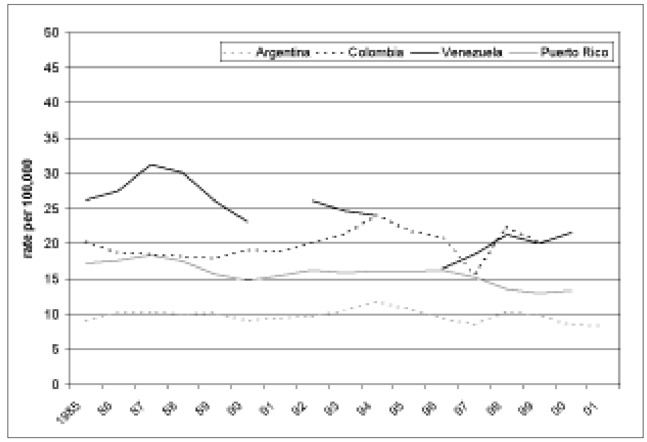
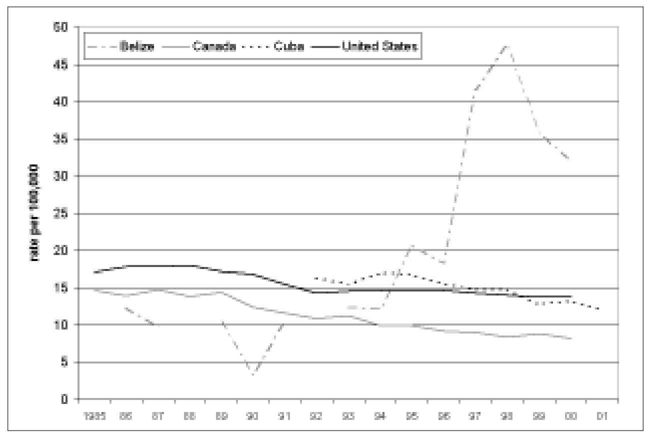


Figure 3: Trends of MVTA in Belize, Canada, Cuba, and the United States, 1985-2001



2000).[6,7] In contrast, motor vehicle occupant deaths accounted for 30-50% of MVTA deaths in Argentina, Canada, Cuba, Puerto Rico and United States; 10-25% in Brazil, Colombia, Mexico, and Venezuela and less than 10% in Chile during 1996-2001. The results hightlight the relevance of the information on the characteristics of the injured person, particularly whether he/she was an occupant of a vehicle or a pedestrian, for the design of intervention strategies.

The average crude mortality rate from MVTA observed during 1985-2001 ranged from highs of 22.8 and 21.9 per 100,000 population in Brazil, and Venezuela to lows of 4.8 and 10.0 per 100,000 population in Guatemala and Chile. Similarly, the highest average rates were found among males in Brazil (36.0) and Venezuela (34.6) and the lowest male rates in Guatemala (7.5), Argentina (15.8) and Chile (16.3). Overall, average female crude rates were much lower than males. They ranged from highs of 9.9 and 10.0 per 100,000 population in Brazil and the United States to average lows of 2.0 and 3.9 per 100,000 population in Guatemala and Chile, respectively.

While deaths rates are powerful indicators of the relative magnitude of the problem, they do not measure the full burden of injuries due to motor vehicle crashes. Indicators of morbidity, disability, and the economic cost of injuries, among others, are necessary to provide a full picture of the situation.

Trends in MVTA

Over the period 1985-2001, age and sex standardized rates from motor vehicle traffic accidents shown in Figures 1, 2, and 3 show a declining trend in Mexico, Colombia, Brazil, Canada, United States, Cuba and Puerto Rico; and an increasing trend in Belize and Chile and, from 1996, in Venezuela. The rates were slightly decreasing in Guatemala and steady in Argentina. The effect of the change in ICD revisions is probably reflected in noting that in the year that countries changed to ICD-10 (Brazil, Venezuela 1996; Argentina, Belize, Chile and Colombia 1997; Mexico, 1998; Puerto Rico and United States 1999; Canada 2000 and Cuba 2001), MVTA rates tended to drop and then increase the following year. Belize was the exception when a dramatic two-fold rate increase was observed, which may reflect, in part, changes in ICD and some other unknown effect. Caution should be observed in the interpretation of the rates in Chile which may be underestimated since on average over the period, one third of the deaths from all external causes have been assigned to "events of unknown intent" (ICD-10: Y10-Y34, ICD-9:E980-E988) and may include deaths involving motor vehicles. This proportion varies over time and might also affect the actual trend. Average age standardized rates from motor vehicle traffic accidents in this period showed that Venezuela and Brazil had the highest rates, 24.1 and 24.2 per 100,000 population, respectively, while the lowest average rates were found in Guatemala and Argentina, 6.1 and 9.7. Among males, the highest average age standardized rates again were found in Brazil and Venezuela, 38.0 and 38.8 per 100,000 and lowest in Guatemala and Argentina, 9.7 and 15.0, respectively. Among females, the United States and Venezuela had the highest average age standardized rates, 9.5 and 9.6 respectively, and Argentina and Belize the lowest, 4.7 and 6.3, respectively. Masculinity mortality ratios (the ratio of age standardized male: female deaths per 100,000) with values over 1.0 indicating "excess" male mortality, highlight the relative severity of this problem in males. These ratios ranged from an average of 2.3 in Canada and United States to around 4.0 in Puerto Rico, Venezuela, Guatemala, and Chile, and to 5.4 in Belize during 1985-2001. Excess male mortality increases the number of widows and orphans and exposes them to a higher risk of economic difficulty.

Figure 4: Age-specific death rates from MVTA per 100,000 population, Brazil, 2000

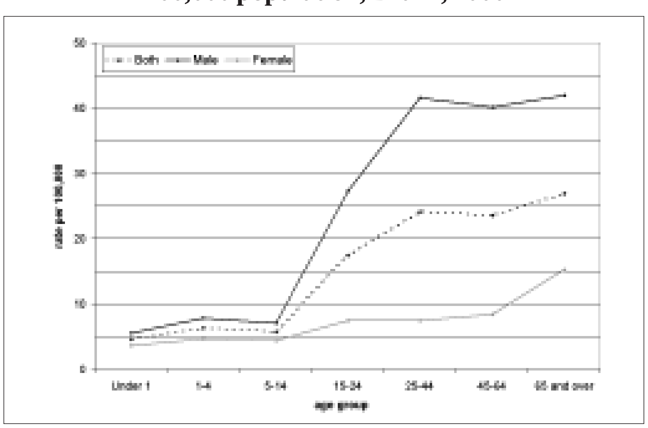


Figure 5: Age-specific death rates from motor vehicle traffic accidents per 100,000 population, Canada, 2000

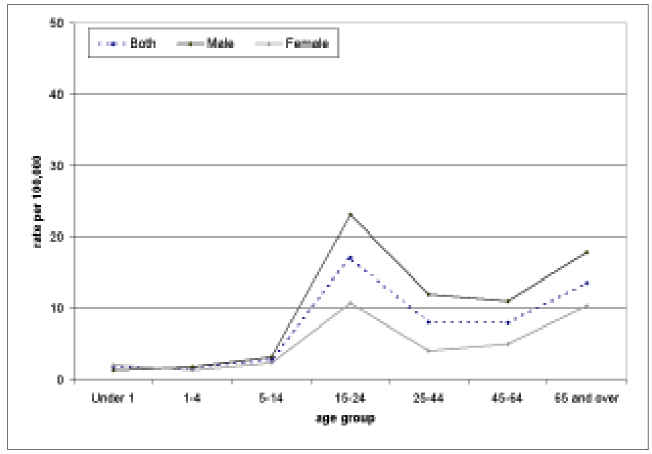
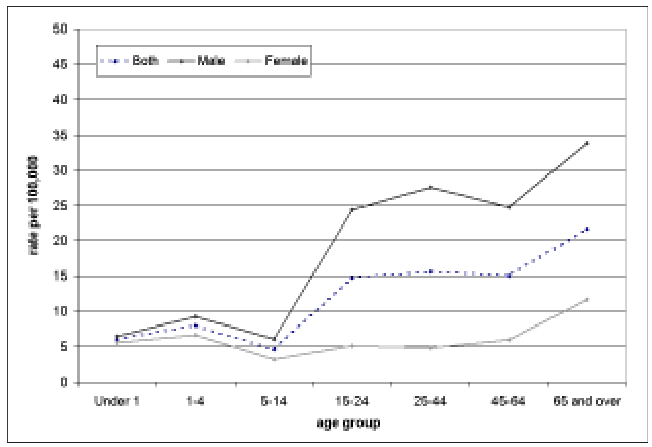


Figure 6: Age-specific death rates from motor vehicle traffic accidents per 100,000 population, Mexico, 2001



As can be seen in Figures 3, 4, and 5, age specific death rates show a similar toll of excess male to female deaths per 100,000, in Brazil, Canada and Mexico, particularly after age 15. The age specific death rates, especially in males, observed in Brazil, 2000 demonstrate a rapid increase in MVTA mortality from 5-14 years of age to the most vulnerable age groups 15-24, 25-44 and 45-64 years of age. The trend is similar in Mexico 2001, but with smaller increases observed in the age groups 25-44 and 45-64 years of age. In contrast, age specific

rates in Canada in 2000 increase from 1-4 to a maximum at 15-24 years of age then decrease through 45-64 and then increase in those aged 65 years and over. This is consistent with the finding that in high income countries, adults aged between 15 and 29 have the highest rates of injuries. [4] Contributing risk factors for this age group include infamiliarity with vehicles, thrill-seeking and over-confidence, less tolerance of alcohol compared with older people, and excess or inappropriate speed.[4] In Puerto Rico (2000) and United States (2000), similar decreases in rates from ages 15-24 to 25-44 year were seen, while rate decreases were also seen in these age groups for females in Belize (2000), Cuba (2001), Argentina (2001), and Venezuela (2000) [data not shown]. Overall, elderly people are more likely to be killed or seriously disabled than younger people due to their lack of resilience.[4] These preliminary results suggest the need for a more detailed analysis on the risk factors involved prior to suggesting interventions in a more specific way.

Injury prevention

To a large degree, MVTA are preventable and can be influenced through national policy decisions, education and individual choices. As the number of cars increases, the roads have become more dangerous and the expected number of deaths and injuries will continue to rise relative to the number of vehicles on the road. The most important risk factors for motor vehicle injury identified are driving while impaired by alcohol or drugs and failing to use occupant protection (e.g., safety belts, child safety seats, and motorcycle helmets), speeding, poor road planning and road construction which does not plan for the interaction of different road users, especially pedestrians, unsafe vehicle design and inadequate implementation of road safety measures. Increasing the standards for motor vehicle crash worthiness and proper road design can, however, reduce their frequency and/or prevent crashes. It is nevertheless important to note that risk factors vary from one setting to the other, and that only high quality data on the nature of the crash and of the injured persons will allow for adequate prevention strategies to be put in place.

Researchers over the years have generated evidence on the injury problem, its risk factors, and ways to prevent motor vehicle fatalities long before changes occurred in public policy and legislation. They have noted the increased risk of motor vehicle accidents with drinking and driving and, the life-saving effects of the use of seat belts and occupant restraints for infants and small children. Unfortunately, data alone cannot always bring about changes in policies that affect individual behavior. Further, prevention strategies need to be customized to the specific situation of countries and not all measures work in all settings. The data that is collected needs to be analyzed and demonstrate the health, social and economic impact of road traffic injuries as well as to monitor and evaluate road safety interventions. Public support for enforcement, enactment of new laws, road safety education and implementation of mass transportation systems and insurance programs to cover health care costs of victims has led to reductions in motor vehicle fatalities yet the toll is still high. Successful strategies in reducing injuries suggest a multi-sectoral approach involving the sectors of health, transport, education, law enforcement and environment. Governments have a critical role to play in prevention efforts and in creating, fostering and maintaining an environment for road safety.

References:

(1) A 5-year WHO strategy for road traffic injury prevention. Department of Injuries and Violence Prevention, World Health Organization. 2002.

(2) Global road safety crisis. Report of the Secretary-General. (A/RES/57/309). United Nations, N.Y. 2003

(3) WHO. The Injury Chart Book. Geneva 2002

(4) World Health Organization. World Report on Road Traffic Injury Prevention. WHO: Geneva. 2004

(5) Pan American Health Organization, Technical Information System, Area of Health Analysis and Information Systems, 2004.

(6) Pedestrian traffic injuries in Mexico: A country update. Martha Hijar, et.al. *Injury Control and Safety Promotion* 2003, Vol. 10, No. 1-2, pp. 37-43

(7) Road traffic injuries in Colombia. Deysi Yasmin Rodriquez, et. al., *Injury Control and Safety Promotion* 2003, Vol. 10, No. 1-2, pp. 29-35

Source: Prepared by Mr. John Silvi from PAHO's Area of Health Analysis and Information Systems (AIS)

Avian Influenza

Avian Influenza

Since mid-December 2003, a highly pathogenic epidemic of avian influenza type A (H5N1) has been reported in domestic and other types of birds. As of 10 February 2004, cases have been reported in eight Asian countries (Cambodia, China, Indonesia, Japan, Laos, Republic of Korea, Thailand and Viet Nam)[1]. Although the majority of episodes of these infections are self-limited, they generate heavy human and economic losses. Some of these strains have demonstrated a unique ability to cause infection and serious disease in human beings. Apart from the immediate risk of transmission to human beings in close contact with infected birds, the widespread geographical presence of H5N1 increases opportunities for human coinfection with bird and human influenza virus. Such events increase the opportunities for antigenic

recombination and the appearance of a new influenza subtype with pandemic potential. To date, the number of infections by H5N1 in humans has been limited, but with high mortality. This situation has been reported in two countries, Viet Nam, and Thailand, which have had outbreaks in domestic birds. In the last decade, progress has been made in the knowledge of the technology for vaccine production, the sale of antiviral drugs licenses, the diagnosis and the recognition of a widespread viral circulation, in order to optimize the clinical management of this disease.[2]

Influenza experts agree that another influenza pandemic is unavoidable and perhaps even imminent (Figure 1). (3) An important challenge to control influenza is the magnitude of the animal reservoirs. It is not possible to prepare reagents and vaccines against all the strains of influenza found in animal reservoirs, and consequently, the viral subtypes for their preparation should be prioritized. Preliminary results of surveillance have identified subtypes H2, H5, H6, H7 and H9 of type A influenza as very probable to be transmitted to human beings. The type A influenza currently circulating in humans corresponds to subtypes H1 and H3, which continue to experiment antigenic changes.[3]

Characteristics of the virus and modes of transmission

There are three known types of RNA genome virus in the Orthomyxoviridae family: A, B, and C. The superficial antigens are of particular interest for immunity and epidemiology. These antigens, which reside in different protein subunits of the viral sheath, are hemagglutinin (H) and the neuraminidase (N). There are 15 known subtypes for the A type hemagglutinin antigens (H1 to H15) and nine subtypes for the neuraminidase antigens (N1 to N9).[4]

The variations of the principal H and N antigens are the causes for the changes in epidemiology and epizootiology of type A influenza (Kaplan, 1982).

This tendency of influenza viruses to experience frequent and permanent antigenic shifts makes it necessary to constantly monitor the global situation of influenza and to adjust the composition of vaccines against the disease annually. These two activities have been the cornerstone of WHO's Global Influenza Program since its creation in 1947.

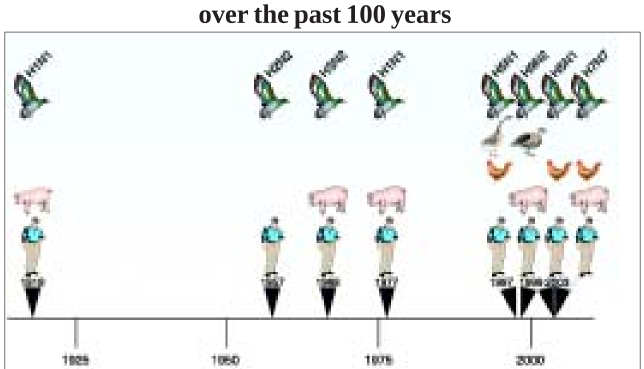
Influenza viruses present a second characteristic of great concern for public health: type A influenza viruses, including the subtypes of different species, can exchange genetic material and fuse. This exchange process, known as antigenic drift, results in a new subtype of the virus that is different from the two reproducing viruses. Since the populations lack immunity against the new subtype and there are no vaccines conferring immunological protection, antigenic drift have historically resulted in highly lethal pandemics. For that to happen, the new subtype should contain human influenza genes making it easily communicable from one person to another during a sufficient period of time.

Various subtypes of the type A virus have been found in birds, which is attributed to the great antigenic combination potential of the virus. Influenza viruses have been isolated from domestic birds (chickens, ducks, turkeys) and from wild birds such as sea swallows (*Sterna hirundo*), wedge-tailed shearwater (*Puffinus pacificus*), wild ducks and other species.[4] A characteristic feature of these birds is that the influenza virus multiplies both in the respiratory system and in the intestines and, once eliminated through the feces, the agent contaminates the environment. Aquatic birds, especially domestic and wild ducks, have raised special concerns. The virus can be isolated from of the cloaca of these birds and lakes where they swim.[5]

Recent research has demonstrated that after circulating in a bird population for a period of time – sometimes short, viruses with low pathogenicity can mutate to highly pathogenic and virulent viruses. During an epidemic in the United States, in 1983-1984, the H5N2 virus initially caused low mortality, but after 6 months, it became highly pathogenic, causing fatalities in 90 percent of the cases. Control of the outbreak required the destruction of over 17 million birds, with a cost of almost 65 million dollars. During an epidemic in Italy in 1999-2001, the virus H7N1, which was initially not highly pathogenic, mutated to a highly pathogenic strain in an interval of 9 months. More than 13 million birds died or were destroyed. [5]

The quarantine of infected poultry farms and the destruction of the infected or potentially exposed populations are standard control measures to prevent the dissemination to other farms and the eventual establishment of the virus in

Figure 1: Timeline of human influenza over the past 100 years



The black triangles represent documented human influenza A infections characterized by multiple cases. In each instance the species of animals implicated in the emergence of disease is highlighted. Since 1997 there has been a disproportionate increase in the number of reports of novel subtypes in humans and in the number of animal and bird species involved, suggesting that the next influenza pandemic is imminent.

the poultry population. Aside from being highly contagious, avian influenza viruses are easily transmitted mechanically from farm to farm, for example through contaminated equipment, vehicles, food, cages or clothes. Highly pathogenic viruses can survive in the environment during long periods, especially at low temperatures. However, strict sanitary measures in farms can confer a certain degree of protection.

It is believed that the enabling environment for the genetic changes involves humans that live in proximity with domestic fowl and pigs. Since pigs are susceptible to infection both by the avian and mammal virus, including the human strains, they can behave as a "melting pot" in which the breeding materials from the human and avian viruses combine, resulting in a new subtype of the virus. However, recent events have identified a second possible mechanism, through direct contact of humans with birds. This subtype mutates rapidly and has a documented tendency to acquire genes from virus that infect other animal specials. Its capacity to cause severe disease in humans has been documented in two occasions. Further, laboratory studies have shown that the isolated viruses are highly pathogenic and may cause severe disease in humans. Birds that survive the infection excrete the virus for at least 10 days, both orally and fecally, which facilitates even further its dissemination in live bird markets and through migratory birds.

Background

Avian influenza viruses normally do not infect species other than birds and pigs. The first case of human infection by an avian influenza virus was documented in Hong Kong in 1997, when the H5N1 strain caused severe respiratory disease in 18 humans, six of which died. The infection of humans coincided with an epidemic of highly pathogenic avian influenza in the poultry population of Hong Kong, produced by the same strain.

There was another alert in February 2003 in Hong Kong, when an outbreak of H5N1 avian influenza caused two cases and a death in a family that had recently traveled to the south of China. Another member of the family, who was a minor in age, died during such visit but the cause of death is unknown. Recently, two additional avian influenza viruses have caused disease in humans. In Hong Kong in 1999, there were two mild cases of H9N2 avian influenza in children and another case in mid-December 2003. The H9N2 subtype is not highly pathogenic in birds. An outbreak of highly pathogenic H9N2 avian influenza, which started in the Netherlands in February 2003, caused the death of a veterinarian and mild disease in 83 additional people two months later.

The most recent cause for alarm occurred in January 2004 in Viet Nam and Thailand, where the presence of avian H5N1 influenza virus was confirmed and 8 countries reported epizootics in birds.

Based on the historical patterns, it is to be expected that influenza pandemics occur 3 to 4 times every century on average, when new subtypes of the virus appear that are easily transmitted from one person to another. However, it is not possible to predict an influenza pandemic. During the 20th century, the pandemics of 1957-1958 and 1968-1969 followed the great 1918-1919 influenza pandemic, which caused 50 million deaths around the world.

Experts agree that another influenza pandemic is unavoidable and possibly imminent. The majority of influenza experts also agree that the immediate sacrifice of the entire poultry population of Hong Kong in 1997 probably prevented a pandemic.

The existing information on the clinical course of the human infection by H5N1 avian influenza virus is limited to case studies of the outbreak of 1997 in Hong Kong. In this outbreak, the patients developed symptoms such as fever, angina, cough and, in several of the fatal cases, severe difficult breathing secondary to viral pneumonia. Those affected were previously healthy adults and children, and some people with chronic medical conditions.

As of 24 February 2004, a total of 32 human cases of type A (H5N1) influenza have been confirmed in laboratory in Viet Nam and Thailand. Of those, 22 (69%) have died. The H5N1 viruses identified in Asia in 2004 are antigenically and genetically different from the 1997 viruses and seem to be associated with fatal infections in domestic fowl and in a variety of wild bird species, which is unusual. The report published in the WHO's Weekly Epidemiological Record (13 February 2004) provides a preliminary clinical description of five laboratory-confirmed cases in Thailand. Four of those were in boys between 6 and 7 years of age, all previously healthy. Four patients notified deaths in the domestic fowl of their family and two of them reported having touched a sick chicken. One had sick chickens in his neighborhood and reported having played near a cage. The patients were taken to the hospital 2 to 6 days after the onset of fever and cough. Other first symptoms included sore throat, rhinorrhea and myalgia. Dyspnea was reported in all the patients 1 to 5 days after the appearance of symptoms. Radiological changes were present in all the patients, with irregular infiltrates in four and interstitial infiltrates in one of them.[1]

The diagnostic tests for all strains of animal and human influenza are fast and reliable. Many laboratories of WHO's global influenza network have safe areas and the appropriate reagents, in addition to considerable experience, to carry out these tests. Fast clinical tests for the diagnosis of influenza also exist, but they are not as precise as the laboratory test that are currently necessary for achieving a complete under-

standing of the most recent cases and to determine if the human infection is spreading, either directly from the birds or from one person to another.

Antiviral drugs, some of which can be used both for preventive treatment, are clinically effective against the A strains of the influenza virus in healthy adults and children, but have some limitations. Furthermore, some of these drugs are expensive and in limited supplies. Until the vaccines can be prepared, a world influenza strategy would require the storage of antiviral influenza drugs for use in the case of a pandemic. However, it has been shown that few countries have this stock. Nevertheless, others have begun to collect antiviral drugs.[3]

There is also considerable experience of producing influenza vaccines, particularly to adjust the composition of the vaccine every year to the variations due to the antigenic drift of the circulating virus. However, at least four months would be required to produce a new vaccine, in significant quantities and able to confer protection against a new subtype of virus.

The highly pathogenic avian influenza caused by H5N1 that began in mid-December 2003 in the Republic of Korea and is currently being reported in other countries of Asia is, as a result, of special importance to public health. In 1997, the variants of H5N1 demonstrated an ability to infect humans directly and have done it again in January 2004 in Viet Nam and Thailand. The spread of the infection among the birds increases the timeliness of direct infection to humans. If more people acquire the infection, as time passes the risk also increases that humans, if jointly infected by avian and human influenza strains, could also serve as “melting pots” for the appearance of a new subtype with sufficient human genes to be transmitted easily from one person to another. This would constitute the onset of an influenza pandemic.

There are several measures available to minimize the risks for global public health that could arise as a consequence of major outbreaks of H5N1 avian influenza in birds. An immediate priority is to stop the additional spread of epidemics among the bird populations. This strategy is effective in reducing the opportunities for human exposure to the virus. The vaccination of people at high risk of exposure to infected birds with the existing effective vaccines against the influenza virus strains in circulation can currently reduce the probability of human co-infection by strains of avian and human influenza and thus reduce the risk that genetic exchange occurs. The workers involved in the slaughter of bird flocks should be protected from the infection with adequate clothing and equipment. These workers should also receive antiviral drugs as a prophylactic measure.

While these activities can reduce the possibility of an emergency for a pandemic strain, it is not possible to determine with certainty if another influenza pandemic can be prevented.

WHO emphasizes three strategic goals: to prevent an influenza pandemic, to control the current human outbreaks and prevent the additional spread, in addition to the realization of necessary research for better preparation and response, including the fast development of an H5N1 vaccine for humans. Additional information, including the progress of the epidemic and technical standards is available on WHO’s avian influenza web site: http://www.who.int/csr/disease/avian_influenza/en/

In light of the threat that the next influenza pandemic may include a virus with the capacity to spread between humans, the most urgent needs are:

1) Sufficient supplies of drugs in order to reduce the severity and spread of the infection.
2) A vaccine for the subtype of the strain of the emerging influenza pandemic that has gone through clinical trials and that manufacturers are prepared for “increasing” production. Such a vaccine would not probably coincide antigenically with the emerging strain and would not prevent the infection, but could reduce the severity of the disease until a specific vaccine is made. The production of such vaccines has been pending for 20 years. None is available but specific plans to produce it are currently being formulated.
3) Improve the world capacity for the manufacture of influenza vaccines for the inter-pandemic periods. Without special efforts, the currently inadequate capacity will not be increased rapidly.

The conclusion of this analysis is unavoidable: The world will be in serious difficulties if the imminent influenza pandemic hits this week, this month or even this year. It is time to advance toward the preparation of contingency plans for a pandemic and take action for the production of the recommended vaccines.[3]

References:

(1) WHO. Weekly epidemiological record, 13 February 2004, 79th year. No. 7, 2004. http://www.who.int/wer
(2) Karl G. Nicholson, John M. Wood, Maria Zambon. Influenza. The Lancet. Vol 363. November 22, 2003
(3) Richard J. Webby and Robert G. Webster. SCIENCE. Vol 302. 28 November 2003
(4) Pedro N. Acha y Boris Szyfres. Zoonosis y enfermedades transmisibles comunes al hombre y a los animales. Tercera edición. Publicación Científica y técnica No. 580 2003 Pág. 329
(5) OMS- Influenza Aviar- Ficha descriptiva- 15 de enero del 204
(6) WHO- confirmed human cases of Avian Influenza A(H5N1). http://who.int/crs/disease/avian_influenza/country/cases_tables_2004_02_23/en/

Source: Prepared by the PAHO’s Area of Disease Prevention and Control, Communicable Diseases Unit (AD/DPC/CD)

Situation of Severe Growth Retardation in First-grade Schoolchildren in Countries of Central America Around 2000

Introduction

The nutritional status of schoolchildren is a relevant aspect of health situation analyses. This status can be seen, on the one hand, as a reflection of life conditions, human development, food safety, and the health of children and, on the other, as an indicator of the risk (vulnerability) to develop acute/severe episodes of malnutrition and other health impairments. Chronic malnutrition, which is reflected in growth retardation among school-age children, is the most frequent form of malnutrition of the Region of the Americas[1].

According to data published by the Pan American Health Organization (PAHO), the Central American countries have long presented levels of malnutrition in their children population, in many cases serious malnutrition. For example, in Honduras the prevalence of malnutrition in children under 5 increased from 48.6% in 1987 to 52.5% in 1991, and 2.1% of deaths in children were associated to malnutrition. Moreover, in Guatemala, there were 45 deaths per 100,000 population due to malnutrition in 1994, while the Survey of Sentinel Schools showed 64% of girls and 75% of boys under 6 had a height-for-age deficit. Meanwhile in El Salvador, the 1993 National Family Health Survey determined that the prevalence of low height for age in children under 5 was 22.8% [2].

The measurement of height-for-age of schoolchildren represents a simple method for the evaluation of the average nutritional status of a population. In turn, the evaluation of growth retardation through periodic height censuses allows monitoring the nutritional status of a population and confirming changes on it. This and other information allows the analysis with various regional risk factors. The objectives of this first paper were: 1) to define the magnitude and distribution of the prevalence of Severe Growth Retardation (SGR) in schoolchildren in countries of Central America; and, 2) to evaluate the relationship between nutritional status and selected environmental risk factors.

Materials and methods

The area of study covers three contiguous countries of Central America: El Salvador, Guatemala, and Honduras. Estimates for the year 2000 indicate that, together, these countries had an approximate total population of 24.1 million, living in about 900 municipalities[3].

The population under study involved first grade schoolchildren of both sexes, ages 6 to 9 years. The data come from the National Schoolchildren Height Censuses of El Salvador in 2000, Guatemala in 2001, and Honduras in 1997.

The nutritional status was assessed through height-for-age measurements, through an anthropometric methodology and previously validated standard instruments[4]. Children's SGR was defined as three or more standardized normal deviations (z-scores) of individual height with respect to the standard reference for age and sex, according to the World Health Organization[5,6,7]. The individual data were summarized in tables, histograms and boxplots utilizing the statistical package SPSS[8].

The analysis of the nutritional status was also done at the population level, with municipalities as unit of analysis. To this end, the individual database was consolidated in accordance with the scores, and the proportion of SGR was calculated in children studied in each municipalities.

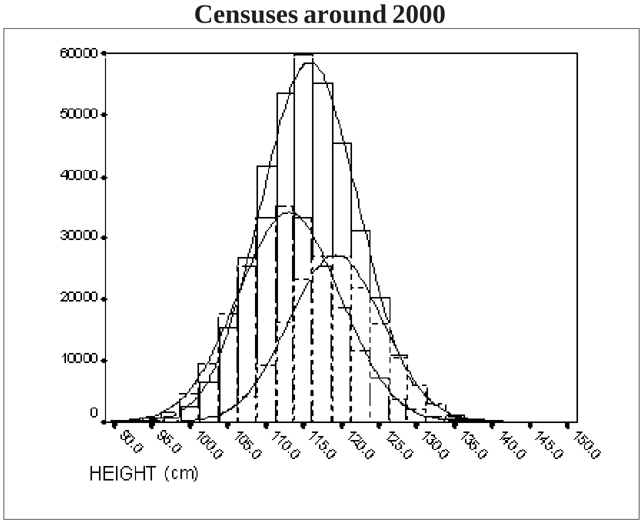
The geographic data of the national and first subnational levels were obtained from the World Digital Atlas and reviewed by PAHO[9]. This electronic database is to the 1:100,000,000 scale. The geographical databases for the second subnational level were provided by the Ministry of Agriculture and Livestock of Guatemala[10], by the Honduras and El Salvador Ministries of Health and the Digital Atlas of Central America, prepared by several institutions in response to Hurricane Mitch[11], compiled by PAHO. Given the fact that at the time of this evaluation, there is not information on food availability and production at municipal level for the study area and given the recognized influence of the environmental factors on food production, the environmental information is analyzed using proxy indicators such as terrain access conditions and land use. Access problems are positively related with topography[12,13]. For this study topography was obtained and calculated from the Digital Elevation Model (DEM) based on data from the United States Geological Survey[14]. Two tiles were employed, W140N40 and W100N40 for the construction of the Irregular Triangular Network (TIN) and slope features calculated each 250 meters above sea level for the set of the three countries. The land use is commonly associated to the distribution of major natural ecosystems and land exploitation patterns for agriculture, livestock, forest, or urban settings[15]. Land use is evidence of the man's action over geographical environment. Its alterations are direct outcomes of the development of economic activities[16]. The influence of environmental factors on food vulnerability is linked to its aptitude for agriculture activities, where soil quality is essential, but varies in relation to drainage, elevation gradients, erosion, temperatures, and rains[17]. Among countries with low tech agriculture activities, distribution of agricultural land use has a decisive impact on food availability[18,19].

Table 1: Distribution studied population for each country, sex and average values and standard desviation by age, height and Z score, around 2000.

Subregion	Number (%)	Average age in months (S.D.)*	Average height in cm (S.D.)	Average Z score (S.D.)	Severe retardation (%) **
Total	782,905	93,0 (11,1)	115,7 (6,9)	-1,72 (1,13)	95.965 (12,3)
Males	404,834 (51.7)	93,3 (11,1)	116,1 (6,8)	-1,82 (1,16)	60.475 (14,9)
Females	378,071 (48.3)	92,7 (11,1)	115,3 (6,9)	-1,61 (1,08)	35.490 (9,4)
El Salvador					
Total	169,719	93,6 (10,2)	119,2 (6,3)	-1,12 (1.04)	5.202 (3,1)
Males	87,492 (51.6)	94,0 (10,3)	119,6 (6,2)	-1,19 (1.08)	3.554 (4,1)
Females	82,227 (48.4)	93,1 (10,2)	118,7 (6.3)	-1,04 (1,00)	1.648 (2,0)
Guatemala					
Total	380,578	95,8 (10,5)	115,7 (6,5)	-1,94 (1,03)	55.370 (14,5)
Males	197,426 (51.9)	96,0 (10,5)	116,1 (6,4)	-2,03 (1,05)	34.988 (17,7)
Females	183,152 (48.1)	95,7 (10.6)	115,3 (6,5)	-1,84 (0,99)	20.382 (11,1)
Honduras					
Total	232,608	88,0 (10,9)	113,2 (6,8)	-1,79 (1,18)	35.393 (15,2)
Males	119,916 (51.6)	88,4 (11,0)	113,5 (6,2)	-1,92 (1.21)	21.933 (18,3)
Females	112,692 (48.4)	87,6 (10,8)	112,8 (6,8)	-1,67 (1.14)	13.460 (11,9)

* Standard deviation
** Severe retardation means a Z score higher than 3 standard deviations compared to the reference

Graph 1: Distribution of height in first-grade children in El Salvador, Guatemala, and Honduras from National Censuses around 2000



For geographical analysis, the geographic information systems package SIGEpi[20] was used, developed by PAHO[20]. In order to link the geographical layers with data on the prevalence of SGR, the municipal codes of each country were used as reference keys. Thematic rank choropleth maps were prepared with the variables of interest, using the quantile method for the classification of units. Furthermore, various area spatial queries were used to determine the geographical relation of critical areas of SGR to the selected risk factors.

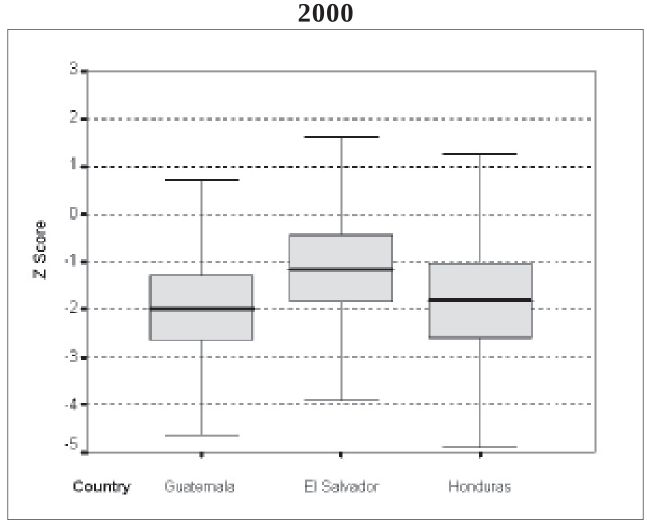
Results

Based on the height censuses, information on 782,905 children was included, 21.7% from El Salvador, 48.6% from Guatemala, and 29.7% from Honduras (Table 1). Among the total of surveyed schoolchildren, 48.3% were female, where the proportion was similar in all countries. With respect to the ages, the children from Honduras were, on average, 6 and 8 months younger than those from El Salvador and Guatemala, respectively.

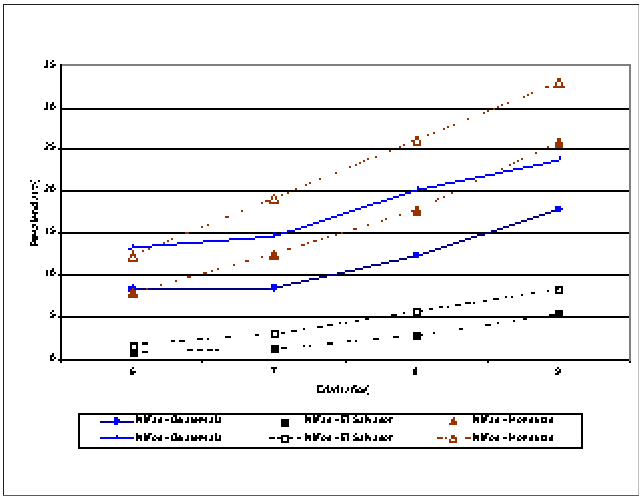
The average height of the entire population studied was 115.7 cm (standard deviation of 6.86); this average was 4 and 6 cm greater in El Salvador (119.2 cm), than in Guatemala (115.7 cm) and in Honduras (113.2 cm), respectively. The average subregional values for men and women were 116.1 and 115.3 cm; this difference of 1 cm between sexes was similar in the 3 countries. The distribution of height values per country is presented in Figure 1, showing a displacement to the left of the curve and height average in Honduras compared to Guatemala, and Guatemala compared to El Salvador.

The Z score was used to consider the effects of age and sex on the population height comparisons. The average subregional Z-score for height with regard to the standard population was of -1.72 (Table 1), which indicates that, on average, children of the subregion are smaller than the reference children. The lower value was observed in Guatemala (-1.94) and the highest in El Salvador (-1.12), while the value in Honduras was in a situation closer to that of Guatemala (-1.79). Even though the height averages were

Graph 2: Distribution of Z scores of height with respect to the reference in first-grade children, by country, around 2000



Graph 3: Prevalence of severe growth retardation in first-grade children in Centroamerican countries, by sex, around 2000



greater among boys than girls, the Z-scores average of—1.82 and -1.61 indicated a less favorable situation among men than in women compared to the standard. The differences between men and women are maintained at the country level. The distribution of the Z-scores at the country level indicates that a segment of the populations of each of them is at important disadvantage with regard to the standard (Figure 2), although in Guatemala and Honduras nearly half are two or more deviations away from the reference, in contrast with El Salvador where less than 25% are in that position. Furthermore, in Honduras a greater dispersion is observed with more extreme Z values, also suggesting important inequalities.

A total of 12.3% of the studied schoolchildren at the subregional level showed a SGR (Table 1). In the different countries, SGR was 3.1% for El Salvador, 14.5% for Guatemala, and 15.2% for Honduras; an excess risk of SGR being noted among boys compared to girls, from 53 to 100%, independently of the level of retardation in the countries. At the subregional level, a sustained increase in the frequency of SGR with age was also noted, from 8.8% at 6 years of age up to 12.3% at 9 years, but the levels are significantly lower in El Salvador (Figure 3). According to sex, the rising trend, and the excess among boys remains relatively constant, regardless of the level of the country. A higher prevalence is observed among boys in Honduras, which increases as age does, like the slope of the curve shows. In view of this trend and considering that the average age of schoolchildren in the Honduran Census was younger than in El Salvador and Guatemala (which is also reflected in a smaller average height in Honduras), it is expected that, if the growth retardation frequency with age were maintained and older children were included, the prevalence of SGR would also be higher in Honduras.

In Map 1, geographical distribution of SGR prevalence is presented at the municipal level for the three countries. When classified by quintiles, the prevalence of SGR was found to be lower than 3.6% in 178 (20%) of the 888 municipalities with 134,872 schoolchildren, 2,808 of which presented SGR. In contrast, another fifth of the municipalities, with 100,329 schoolchildren, shows levels higher than 22%; however, among these some units had prevalence figures up to 72.7%. The municipalities that belong to this superior quintile can be defined as the most critical areas, where 31,679 of the schoolchildren, i.e. nearly 30% have SGR. Municipal clusters can be identified where the prevalence of severe deficit is higher than 21% for the west of Honduras and Guatemala, but not for El Salvador, which suggests the existence of some factors that increase risk in such areas.

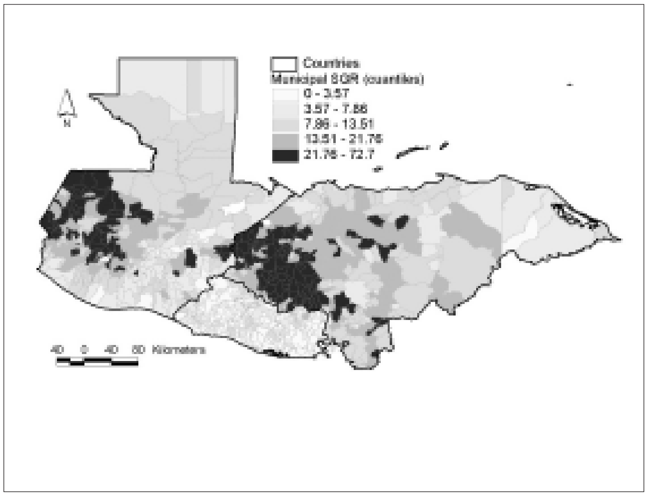
The environmental factors under study integrate some elements that could influence the production, availability or access to food supplies. Under abrupt topographic conditions, areas that would have greater access difficulties cover Western Guatemala mountain areas, which continue towards the South East, along the border between Honduras and El Salvador (Map 2). This ecosystem is known as the Central American pine-oak forest, typified by mixed needle and broad leaves mountainous woodland[21] (Map 3). Information about natural or man's modified ecosystems' distribution was integrated and measured, taking into account the proportion of agricultural landuse with respect to the municipal total surface (Map 4). Landuse patterns corroborate that more intensive agricultural activities predominate alongside the South East coasts, as well as over the piedmonts surrounding the pine-oak forest ecosystem.

With geo-processing and digital maps overlapping, the spatial allocation of the critical areas of SGR was analyzed simultaneously with different environmental factors. Critical areas of SGR concur geographically with the ecosystem pine-oak forest, on top of areas of abrupt topography and the additional factor of being located over low agricultural occupation lands. This, besides their adversity for farming activity are also characterized by their low access and coverage of basic services. In turn, critical areas of SGR are apart from terrain agricultural vocation (Map 5).

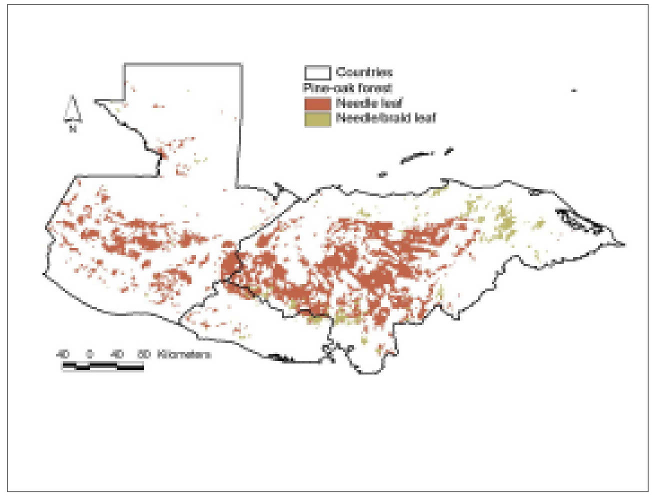
Conclusions

The situation analysis of nutritional status based on height censuses in countries of Central America indicates that SGR is a very frequent public health problem, that deserves special attention in some areas of El Salvador, Guatemala and Honduras. Although SGR is an indicator of chronic malnutrition, it is important to note that vulnerability or risk of developing acute malnutrition episodes of increases with the frequency and severity of observed growth

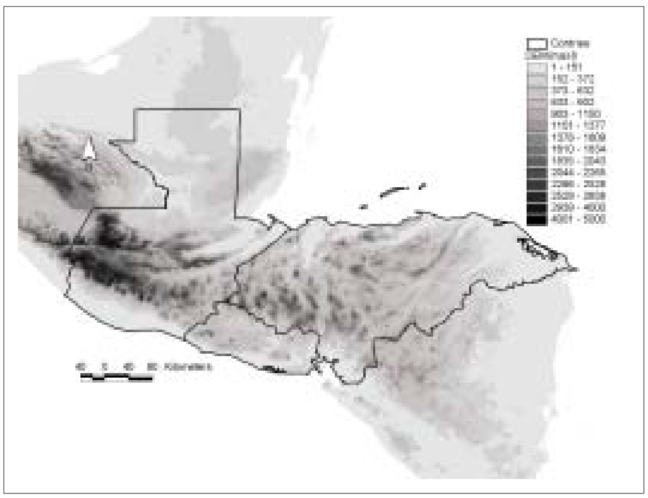
Map 1: Distribution of severe growth retardation in first-grade schoolchidren in the countries under study at the municipal level, around 2000



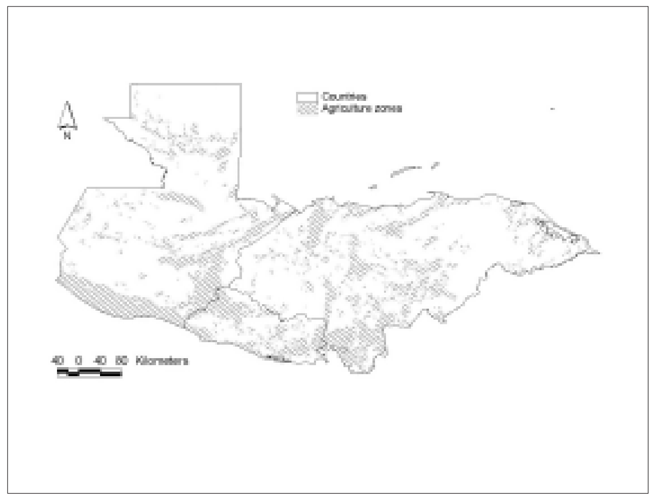
Map 3: Location of pine-oak forest ecosystem according to the soil in the countries under study



Map 2: Digital elevation model in the countries under study



Map 4: Location of agriculture zones



retardation among populations. Distribution of heights and Z-scores by country shows that growth retardation is particularly precarious in Honduras; however, high levels of SGR prevalence of (>22%) also affects groups of municipalities in Guatemala, which means that any intervention should consider both countries.

The present study shows that geographical conditions linked to topography, type of soil and other socioeconomic status are associated with the levels of SGR. Unlike the results presented in graphs, map modelling allows the identification of spatial aggregation patterns such as the ones described for Honduras and Guatemala (Martínez et al,[22]) and the relation with other factors that have different distributions to the political-administrative division, such as land use, and topography. The measurement of environmental factors associated with the risk of SGR, suggests that the identification and monitoring of high-risk populations through such indicators is feasible. However, it is necessary to consider that there exist other social, economic and health factors that have an impact on the nutritional status and growth retardation.

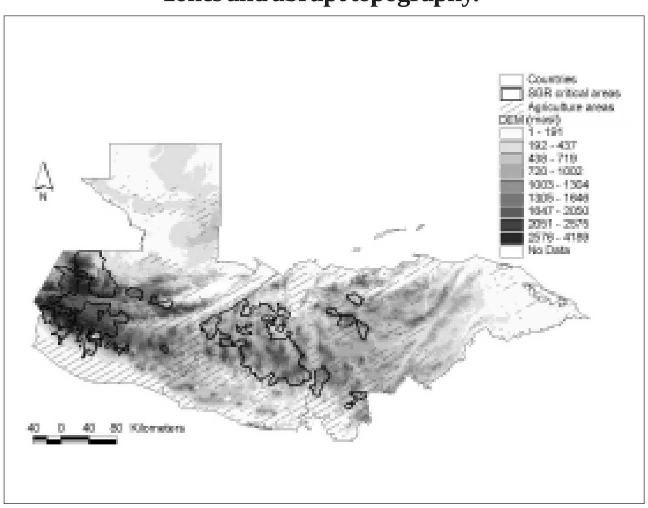
For instance, Nájera-Aguilar et al[23]. have found in Honduras, that there is a high spatial correlation between municipalities with SGR clusters and elevated proportion of indigenous population, as well as low services availability (i.e. roads, health, municipal services as water and drainage). But this is happening just aver abrupt topography areas. The latter indicates the existence of multiple variables that must be analyzed, in order to establish their relative importance in the other countries.

The present study shows an ecological analysis, where the information collected from different sources of information is taken advantage of, both, health conditions at municipal level, and the continuous surfaces that correspond to environmental characteristics - satellite images-, accordingly there are some limitations on the inferences interpretation.

In the results explanation, it is also important to take into account that schoolchildren included in the censuses do not necessarily represent all children between 6 to 9 years old, a situation associated with the access to schools, besides customs of incorporating them early, to productive activities inside and outside the home, as occurs particularly in rural areas. This could mean an underestimation of SGR prevalence if the children not included are from the lowest socioeconomical levels living in mountainous areas. However, in order to evaluate the representativeness of these censuses, it is worthy to indicate, that in Guatemala it was an estimated coverage nearby 97% of the public schools[4], validating that the estimates of prevalence of SGR are an expression of the country's situation.

In short, the high frequency of SGR in countries of the Central American subregion points out to the need for establishing programs and policies aimed at diminishing its occurrence and impact. The Millennium Development Goals contemplate the reduction of poverty, hunger, and malnutrition[24]; the present situation analysis reflects a first step for the process of monitoring and orientation of plans and policies to address such a situation. Moreover, the use of the information on height censuses allows evaluating the magnitude and distribution of SGR, identifying areas or epidemiological strata having similar risk determinants where specific health interventions may be directed.

Map 5: Critical areas or SGR prevalence over agriculture zones and abrupt topography.



References:

1) Organización Panamericana de la Salud (OPS). Enfermedades de la nutrición y el metabolismo. En: La Salud en las Américas, 1998. Vol I. Publ Cient No. 569. OPS: Washington, D.C., 1998. pp:161-168

2) Organización Panamericana de la Salud (OPS). La Salud en las Américas, 1998. Vol II. Publ Cient No. 569. OPS: Washington, D.C., 1998.

3) Organización Panamericana de la Salud (OPS). Situación de Salud en las Américas. Indicadores Básicos 2002. OPS: Washington, D.C., OPS/SHA/ 02.01, 2002

4) Gobierno de la República de Guatemala. Ministerio de Educación. Segundo Censo Nacional de Talla de Escolares de Primer Grado de Primaria de la República de Guatemala. 16 al 20 de julio de 2001. Guatemala: Gobierno de la República-COSAN/COPRE y Ministerio de Educación, 2002.

5) WHO Working Group. Use and interpretation of anthropometric indicators of nutritional status. Bull WHO 1986; 6: 929-41

6) Gorstein J, Sullivan K, Yip R, de Onis M, Trowbridge FL, Fajans P, Clugston G. Issues in the assessment of nutrition status using anthropometry. Bull WHO.

7) Dibley MJ, Staehling N, Nieburg P, Trowbridge FL. Interpretation of Z-score anthropometric indicators derived from the international growth reference. Am J CLin Nutr 1987; 46: 749-62.

8) Statistical Package for the Social Sciences (SPSS). Versión 11.0.1 para Windows. Chicago: SPSS Inc. 2003.

9) Loyola E, Castillo-Salgado C, Nájera-Aguilar P, Vidaurre M, Mujica OJ, Martinez-Piedra R. Los sistemas de información geográfica como herramienta para monitorear las desigualdades de salud. Rev Panam Salud Pública, 2002; 12(6): 415-428.

10) República de Guatemala. Ministerio de Agricultura, Ganadería y Alimentación. (SIG-MAGA), Marzo, 2001.

11) CINDI, USGS, CIAT, ESRI. Digital Atlas of Central America. Prepared in Response to Hurricane Mitch. Version 2.0, January, 1999. CD-ROM.

12) Perry B, Gesler W. Physical access to primary health care in Andean Bolivia. Social Science and Medicine 2000 (50): 1177-1188.

13) Martin D, Wringley H, Barnett S, Rodovick P. Increasing the sophistication of access measurement in rural health care study. Health and Place 2002 (8): 3-13.

14) United States Geological Survey (USGS). http://edc.usgs.gov/products/ elevation/dem.html. Consultado en Noviembre de 2002.

15) World Wild Fund, World Bank, USGS-EROS. Ecoregions. Central America Environment Projects: http://www.worldbank.org/

16) Mayhew S. A dictionary of geography. Oxford paperback reference. Oxford University Press. Oxford 1997.

17) Meade MS, Earickson RJ. "Regionalization of diet and deficiencies". In:. Medical geography. The Guilford Press. Mew York 2000: 43-51.

18) FAO. Land and water development division. http://www.fao.org/ag/agl/landuse/

19) CIAT. Indicadores de vulnerabilidad. Centro Interamericano de Agricultura Tropical. http://gisweb.ciat.cgar/sig/esp/indicadores-vulnerabilidad.htm

20) Martínez R, Vidaurre M, Nájera P, Loyola E, Castillo-Salgado C. SIGEpi: Sistema de Información Geográfica en Epidemiología y Salud Pública. Boletín Epidemiológico OPS. 2001; 22(3):4-5.

21) PROARCA/CAPAS. Proyecto Ambiental Regional de Centro America / Central America Protected Areas Systems, Central American Vegetation/ Land Cover Classification and Conservation Status. Partnership of the CCAD, USAID, IRG, TNC/NASA and Winrock International. Obtained from the CIESIN at Columbia University via FTP.

22) Martínez R., Loyola E., Nájera P., Vidaurre M., Castillo C. Geographical distribution of chronic malnutrition in Guatemala, Honduras and El Salvador. VI Congresso Brasileiro de Epidemiologia. Recife PE 19-23 Junho 2004.

23) Nájera P, Castillo C, Vidaurre M, Martínez R, Loyola E, Lizardo E. Geographic Accessibility to Primary Health Care in Honduras: Urban and Rural inquities. VI Congresso Brasileiro de Epidemiologia. Recife PE 19-23 Junho 2004.

24) Organización Panamericana de la Salud (OPS). Objetivos de Desarrollo del Milenio y Metas de Salud. OPS: Washington, D.C., Documento SPP38/4. 2004.

Source: Prepared by Enrique Loyola, Patricia Nájera, Ramón Martínez, Manuel Vidaurre and Carlos Castillo-Salgado from PAHO's Area of Health Analysis and Information Systems (DD/AIS), and Jesús Bulux, Adán Montes, Humberto Méndez and Hernán Delgado from the Centroamerican and Panama Nutrition Institute (INCAP).

A Glossary for Multilevel Analysis

Ana V. Diez Roux
Divisions of Medicine and Epidemiology, Columbia University
New York, New York, United States

PART III

NON-INDEPENDENCE OF OBSERVATIONS

Refers to situations in which dependent variables for observations at a lower level nested within the same higher level unit (or cluster) are correlated, even after measured characteristics are taken into account. For example, two persons from the same neighbourhood may tend to have more similar blood pressure levels than two persons from different neighbourhoods, even after measured individual and neighbourhood characteristics are taken into account. In the case of repeat measures on individuals over time, two blood pressure measurements on the same person may tend to be more similar than two measures on different persons even after relevant covariates are taken into account. One reason for this correlation may have to do with the omission of important higher level variables that observations within the same higher level unit share. This residual correlation violates the assumption of independence of observations underlying usual regression approaches. Ignoring this correlation may lead to incorrect inferences. Efficiency of estimation may also be reduced.[40] Multilevel models account for potential residual correlation by modelling intercepts and regression coefficients as random (for example, by allowing for macro level errors, U_{0j} and U_{1j} in second level equations, see MULTILEVEL MODELS).

POPULATION-AVERAGE MODELS

Models that account for correlation between lower level units within higher level units (or clusters) by modelling the correlations or covariances themselves rather than by allowing for random effects or random coefficients as MULTILEVEL MODELS do.[40, 46] These correlations are taken into account in the estimation of regression coefficients and their standard errors. Different correlation structures (describing within cluster or within higher level unit correlations) can be specified. "Population-average models" are also referred to as "marginal models"[40, 46] or "covariance pattern models".[26] Whereas multilevel models model the dependent variable conditional on the random effects (or random coefficients), population-average models model the marginal expectation of the dependent variables across the population (in a sense, "averaged " across the random effects). For this reason, marginal models have also been called "population-average" models (as a way to contrast them with SUBJECT SPECIFIC random effects models).[46] The Generalised Estimating Equation (GEE) approach is one approach to fitting marginal models.[46]

Population-average models model the population-average response as a function of covariates without explicitly accounting for heterogeneity across higher level units.[46] In contrast, MULTILEVEL MODELS investigate and explain the source of group to group variation (and of the within group correlation) by modelling group specific regression coefficients as a function of group level variables plus random variation. Therefore, although population-average models account for the correlation between outcomes within higher level units, the source of this correlation is not directly investigated (the correlation, and sometimes higher level effects themselves, are viewed as nuisance parameters that must be taken into account but are not of direct interest). Therefore, population-average models do not allow examination of group to group variation, of the group level or individual level variables related to it, or of the degree of variation present between and within groups, as multilevel models do (see VARIANCE COMPONENTS). Differences between both types of models also have consequences for the interpretation of regression coefficients: in the multilevel model, the regression coefficient estimates how the response changes as a function of covariates *conditional* on the random effects; in the marginal model, the coefficient expresses how the response changes as a function of covariates "averaged" over group to group heterogeneity (or group random effects).[40, 46] In the case of continuous dependent variables these coefficients are mathematically equivalent, but in the case of non-normally distributed variables (for example, logistic models) the marginal parameter values will usually be smaller in absolute value than their random effects analogues.[46, 47]

PSYCHOLOGISTIC FALLACY

An inferential fallacy that may arise from the failure to consider group characteristics in drawing inferences regarding the causes of variability across individuals[1, 2]—that is, assuming that individual level outcomes can be explained exclusively in terms of individual level characteristics. Although the level at which data are collected may fit the conceptual model being investigated (that is, individual level), important facts pertaining to other levels (that is, group level) may have been ignored.[1, 2] For example, a study based on individuals might find that immigrants are more likely to develop depression than natives. But suppose this is only true for immigrants living in communities where they are a small minority. A researcher ignoring the contextual effect of community composition might attribute the higher overall rate in

immigrants to the psychological effects of immigration or to genetic factors, ignoring the importance of community level factors and thus committing the psychologistic fallacy.[1] The term "psychologistic fallacy" is not entirely appropriate because the individual level factors used to explain the outcome are not always exclusively psychological.[2] Although the term "individualistic fallacy"may appear more adequate, it has also been used as a synonym for the related but distinct ATOMISTIC FALLACY.[3, 4] See also SOCIOLOGISTIC FALLACY.

RANDOM COEFFICIENT MODELS

Term originally used for models in which the regression coefficients corresponding to covariates in the model are treated as random rather than fixed[19, 26] (that is, models containing RANDOM COEFFICIENTS, see for example b_{1j} in the entry for MULTILEVEL MODELS). Traditional random coefficient models do not include higher level (or group level) predictors in the group level equations for the covariate effects (that is, in a traditional random coefficient model, equation (3) would be $b_{1j} = \gamma_{10} + U_{1j}$).[19] Thus random coefficient models can be thought of as a particular case of the more general MULTILEVEL MODELS. However, the term random coefficient models is sometimes used more broadly used to refer tomultilevel models generally. See also RANDOM EFFECTS MODELS.

RANDOM EFFECTS/RANDOM COEFFICIENTS

Regression coefficients (intercepts or covariate effects) that are allowed to vary randomly across higher level units (that is, are assumed to be realisations of values from a probability distribution) (see MULTILEVEL MODELS). For example, in the case of persons nested within neighbourhoods, neighbourhood effects can be assumed to vary randomly around an overall mean (random effect, see RANDOM EFFECTS MODELS). Similarly, the effect of personal income on individual health may be allowed to vary randomly across neighbourhoods (random coefficient, see RANDOM COEFFICIENT MODELS). Although the terms "random effects" and "random coefficients" are sometimes distinguished as noted above, they are often used interchangeably. The use of random effects or random coefficients is especially appropriate when the higher level units (or groups) can be thought of as random samples from a larger population of units (or groups) about which inferences wish to be made. See also FIXED EFFECTS/FIXED COEFFICIENTS.

RANDOM EFFECTS MODELS

Term originally used for models in which differences across groups (or other classification system) are treated as random rather than fixed[19, 26] (that is, models containing RANDOM EFFECTS). For example, in the case involving individuals nested within neighbourhoods, a model treating neighbourhood differences as fixed would include all neighbourhoods represented in the sample as a set of dummy variables in a regression equation with individuals as the units of analysis (see FIXED COEFFICIENTS). In contrast, a random effects model would treat neighbourhood differences as realisations from a probability distribution—that is, neighbourhood intercepts would be allowed to vary randomly across neighbourhoods following a probability distribution (see MULTILEVEL MODELS). An underlying assumption is that the neighbourhoods in the study are a random sample from a larger population of neighbourhoods about which inferences wish to be made. Random effects models can be thought of as a particular case of the more general MULTILEVEL MODELS in which only intercepts are allowed to vary randomly across groups (that is, random intercept models). Sometimes, however, the term random effects models is used more broadly to refer to MULTILEVEL MODELS generally (that is, models that allow for both random intercept and random covariate effects). See also RANDOM COEFFICIENT MODELS.

RESIDUAL CORRELATION

See NON-INDEPENDENCE OF OBSERVATIONS.

SOCIOLOGISTIC FALLACY

An inferential fallacy that may arise from the failure to consider individual level characteristics in drawing inferences regarding the causes of variability across groups.[1, 2] Although the level at which data are collected may fit the conceptual model being investigated (that is, group level), important facts pertaining to other levels (that is, the individual level) may have been ignored.[1] Suppose a researcher finds that communities with higher rates of transient population have higher rates of schizophrenia, and he/she concludes that higher rates of transient population lead to social disorganisation, breakdown of social networks, and increased risk of schizophrenia among all community inhabitants. But suppose that schizophrenia rates are only increased for transient residents (because transient residents tend to have fewer social ties, and individuals with few social ties are at greater risk of developing schizophrenia). That is, rates of schizophrenia are high for transient residents and low for non-transient residents, regardless of whether they live in communities with a high or a low proportion of transient residents. If this is the case, the researcher would be committing the sociologistic fallacy in attributing the higher schizophrenia rates to social disorganisation affecting all community members rather than to differences across communities in the percentage of transient residents. See also PSYCHOLOGISTIC FALLACY.

STRUCTURAL VARIABLES

A type of GROUP LEVEL VARIABLE that refers to relations or interactions between members of a group,[13] for example, characteristics of social networks within the group or patterns of contacts or interactions between members of the group. Structural variables are sometimes considered a subtype of INTEGRAL VARIABLES.[12, 18]

SUBJECT SPECIFIC MODELS

Term used to refer to RANDOM EFFECTS/RANDOM COEFFI-

cient models (or multilevel models generally) in order to contrast them with population-average models. "Subject specific" is used because the term was originally developed in the context of longitudinal data analysis,[46] where individuals or subjects are the higher level units and repeat measures are the lower level units. In this case, the fixed effects coefficients derived from a random effects, random coefficient, or multilevel model are conditional on person level (or person specific) random effects, hence the term "subject specific". More generally, they can be thought of as "higher level unit" specific (or cluster specific), because they are conditional or higher level unit (or cluster specific) random effects. For example, in the entry for multilevel models, the estimate of γ_{01} is conditional on group level random effects (as reflected by the presence of U_{oj} and U_{1j}).

Variance components

Using multilevel models the total variance in individual level outcomes (or lower level outcomes generally) can be decomposed into variance within and between groups (or higher level units generally). For example, the variance in blood pressure across individuals can be decomposed into variance within and between neighbourhoods. These components are referred to as variance components. The ability to estimate the variance components (which provide important information on the variability in the outcome between and within groups) is a key feature of multilevel models, and what distinguishes multilevel models from traditional contextual effects models and population-average models. For this reason, multilevel models have also sometimes been referred to as variance component or covariance component models. See also multilevel models.

References:

NOTE: References 1-38 were included in Part I and II of the Glossary, in Vol. 24, No. 3 (2003) and Vol. 24, No. 4 (2003) of the *Epidemiological Bulletin.*

(39) Wong G, Mason W. The hierarchical logistic regression model for multilevel analysis. *J Am Stat Assoc* 1985;80:513–24.

(40) Diggle PJ, Liang KY, Zeger SL. *Analysis of longitudinal data*. New York:Oxford University Press, 1994.

(41) Laird NM, Ware H. Random effects models for longitudinal data. *Biometrics* 1982;38:963–74.

(42) Longford NT. *Random coefficient models*. Oxford: Clarendon, 1982.

(43) Dempster AP, Rubin DB, Tsutakawa RK. Estimation in covariance components models. J Am Stat Assoc 1981;76:341–56.

(44) Searle SR, Casella G, McCullogh CE. Variance components. New York: Wiley, 1992.

(45) Morris C, Christiansen C. Fitting Weibull duration models with random effects. Lifetime Data Anal1995;1:347–59.

(46) Zeger S, Liang K, Albert P. Models for longitudinal data: a generalized estimating equation approach. Biometrics 1988;44:1049–60.

(47) Burton P, Gurrin L, Sly P. Extending the simple linear regression model for correlated responses: an introduction to generalized estimating equations and multi-level mixed modeling. Stat Med1998;17:1261–91.

Source: Published initially as "A glossary for multilevel analysis" in the *Journal of Epidemiology and Community Health*, 56:588-594, 2002.

First Latin American Workshop for Instructors Training of EPIDAT v3.0

EPIDAT v3.0 is a freeware computer program that contains the following modules of Epidemiology and Public Health: Adjust of rates, Demography, Sampling, Probability Distributions, Concordance and Consistency, Diagnostic Tests, Contingency Tables, Inference of parameters, Bayes Analysis, Surveillance in Public Health, Meta-analysis, and Herarchytion.

It is designed for the health professionals with emphasis on the analysis of the public health problems. EPIDAT v3.0 was developed through between The Pan American Health Organization, Health Analysis and Information Systems Area and the Office of the Director Xeral of Saúde Public of the Xunta of Galicia (Spain).

EPIDAT v3.0 was first used in a Latin American Workshop for Instructors Training of EPIDAT v3.0 held in the National Institute of Health of Cuernavaca (Mexico), 7-9 June 2004 twenty-seven professionals representing of 9 countries of the Region of the Americas participated. These instructors are expected to facilitate the dissemination of EPIDAT v3.0 in different academic areas, of research, and of health services of the Region of the Americas.

For more information on EPIDAT v3.0 visit PAHO's Web site (http://www.paho.org/spanish/sha/epidat.htm), or at the Office of the Director Xeral of Saúde Public Web site (http://dxsp.sergas.es).

PAHO's Epidemiological Bulletin is published quarterly in English and Spanish. Catalogued and indexed by the United States National Library of Medicine. Printed on acid-free paper.

Internet: http://www.paho.org/english/DD/AIS/beindexe.htm

PAN AMERICAN HEALTH ORGANIZATION
Pan American Sanitary Bureau, Regional Office of the
WORLD HEALTH ORGANIZATION
525 Twenty-Third Street, N.W.
Washington, DC 20037