

## **The Relevance of Longitudinal Research for Population and Health**

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### **Introduction**

Longitudinal research – also known as panel research or panel studies – is a necessary, recognized tool for studying social change and dynamic behavior due to its ability to track individuals over time to assess change (Gomm, 2000; Ruspini, 2002). Globally, longitudinal research has contributed immensely to improvements in population and health. For example, the collection of detailed information on the same individuals has been a feature of population and epidemiological research for many decades, leading to a greater understanding of the changing nature of major population and health challenges and their contributing factors, ranging from the nature and persistence of major diseases, to poverty alleviation, patterns of migration as well as aging, the effects of changing marital transitions, the influence and control of substance abuse, and the development of health, education and social policies and services.

This paper synthesizes the ways in which longitudinal research has been a valuable tool for analyzing changing trends in population and health and the causal factors contributing to these changes, with special attention to its use in the Asia and Pacific Region. The discussion centers on three key aspects, beginning with an overview of the longitudinal research, its development and changing needs, its distinctive features, and its relevance to population and health research. The presentation continues with a review of the utility of longitudinal studies in population and health research, which is followed by an assessment of the prospects and challenges for longitudinal studies in the Asia and Pacific Region.

## **The Nature of Longitudinal Research**

### **Development and Changing Needs**

Longitudinal is the term coined to differentiate the methodology and utility of this type of research with that of cross-sectional research (Cohen and Lepkowski, 2004). It is not clear who coined the term, but Baltes (1968) noted that the earliest reference to different strategies (cross-sectional and longitudinal) in aging research was made by Camerer who worked in the field of medicine (Camerer, 1910 cited in Baltes, 1968). Based on a biological approach, samples were observed at different age levels in order to determine age-functional relationships (Baltes, 1968). Later on in the late 1940s, the concept of “panel” was introduced, though it was practiced long before. In his analysis of the relationship between radio advertisements and product sales, for example, Paul Lazarsfeld suggested that repeatedly interviewing the same respondents would clarify whether a radio advertisement was the cause or the effect of buying products (Lazarsfeld, 1940 cited in Ruspini, 2002).

A prime principle of panel or longitudinal studies is to link individual data across time. The need for and utility of longitudinal research are extremely relevant today. The growing diversity of changes led by globalization, population trends and epidemiological transitions force researchers to better understand and grasp the nature and processes of change associated with social and behavioral dynamics. Both globalization and macro socio-economic change, in particular, inevitably affect the micro level, such as individuals, families and households, thus producing a diversity of changes (Cohen and Lepkowski, 2004; Rose, 2000). In addition, the demographic landscape also has been altered. For example, during the past 50 years, the Asia-Pacific Region has witnessed several significant transitions, most prominently decreases in fertility and growth rates, increases in life expectancy, and, most importantly, aging populations (Guest, 2006; Knodel, 1999; Prasartkul, 2006; Seetharam, 2002). Moreover, in health related areas, a comparison of population health over time using regular health surveys becomes questionable when challenged by many dynamic problems, which leads to the need to reconsider how the health of populations is measured (Murray et al., 2002).

Several studies have explored the consequences of such changes on population and health, and vice versa (Kim, 2005; Seetharam, 2002; United Nations,

1973). Using data collected over several rounds between 1984 and 2002 in Nang Rong district, Northeast Thailand, Rindfuss et al. (2002), for example, examined how population processes including migration and population pressure are related to environmental and health outcomes. Such panel or longitudinal surveys, in which individuals are tracked over time, have become essential (Davies and Dale, 1994; Murray et al., 2002). As Ruspini (2002) puts it “since the data are collected about the same people at different time points, longitudinal research is able to present information about what happened to a set of units (people, household, firms, etc) across time.

Longitudinal research is thus a key methodology for studying the diversity of change as well as the diversity of changing needs. Understanding this diversity is important for researchers and, especially, for policy-makers. They need to understand the dynamics that underlie key issues (e.g. poverty, unemployment, the elderly) in order for them to properly understand and tackle them at policy and service levels (Ezzati-Rice and Cohen 2004; Kalton, 2004; Rose, 2000).

### **Distinctive Features**

Perhaps the distinctive features of longitudinal research can be best described in relation to their designs and key differences with cross-sectional surveys.

#### *Different possible designs for surveying across time*

A longitudinal survey usually combines both extensive (quantitative) and intensive (qualitative) approaches (Brynan, 1988; Davies and Dale, 1994). At the same time, it can provide cross-sectional, longitudinal data analysis (Kalton and Citro, 2000; Waksberg, 2004) and qualitative multiple-case study analysis (Yoddumnern-Attig et al., 2006). Though there are different types of longitudinal surveys, due to the approach's long history and emerging needs, they can be summarized as follows.

##### **1. Repeated cross-sectional survey or trend analysis**

In repeated cross-sectional survey design, *the main focus is on asking the same question regularly for a long period of time* with a different sample population. Although social change can be captured, the strength lies in measuring changes at an aggregate level (Rose, 2000; Ruspini, 2002; Trivellato, 1999).

##### **2. A panel design.**

This is a prospective method *focusing on interviewing the same individuals repeatedly at regular intervals*, often with the same questions (Harvey and

MacDonald, 1993; Rose, 2000; Ruspini, 2002; Trivellato, 1999). The panel design can be termed differently based on their distinctive features.

*a. Rotating panels.* For this design, a panel is established through probability sampling. Individual panel members are rotated in and out of the panel over a period of time. New members (selected through probability sampling) are added to the new sample at each successive wave (Ezzati-Rice and Cohen, 2004; Rose, 2000; Ruspini, 2002).

*b. Split panels.* A panel is established through a rotating sample and another sample of long-term panel members who are being followed over time (Ruspini, 2002; Sirirassamee et al., 2007).

*c. Cohort panels* are designed to observe intensively people who share a common life event at two or more times. Replacement does not normally take place. *The main focus is on examining the cohort and in its important features, not on specific individuals* (Neuman 2006; Harvey and MacDonald, 1993; Rose, 2000; Ruspini, 2002; Wadsworth, 2004). The strength of the cohort design is in its ability to identify the time dimension, relationships of earlier experiences of the samples and later outcomes (Kalton, 2004).

*d. Household panels* generally aim at gaining an understanding of socio-economic and demographic change at individual and household levels. Anderson, Bechhofer and Gershuny (1994) elaborate on its capability to demonstrate the inextricable links between family members and thus further the investigation of 'household strategies'. In order to achieve its goal, the following features are usually practiced (Guest and Punpuing, 2003; Rose, 2000; Ruspini, 2002).

- Not only the same individuals are repeatedly interviewed, but all adult members in the household are also repeatedly interviewed in successive waves.
- If the members split off from an original household to form new ones but remain in the study area, all adult members of these households are also interviewed.
- When children in each household reach adult age (15 years), they are also interviewed.

*3. Record linkages or administrative panels.* The most important feature of this type of design is the linkages between longitudinal survey and administrative cross-sectional sequences. Data items that are not collected primarily for panel purposes are linked together with administrative records using specific personal identifiers (Baltes, 1968; Ruspini, 2002; Trivellato, 1999). The value added for this particular design may

come from data pooled from several sources that allow the researchers to resolve one or another of the methodological shortcomings in an efficient manner (Baltes, 1968; Buck, 2000; Ruspini, 2002; Waksberg, 2004).

***Key distinctions between cross-sectional and longitudinal surveys***

As opposed to cross-sectional research, data obtained from longitudinal research provide a much sounder scientific basis for making causal inferences with regard to the determinants of changes in population and health conditions. In addition, longitudinal studies are able to overcome the selection effects that confound cross-sectional research, to provide better quality data, and to enable greater specificity in the analysis of the temporal ordering of events.

The following table shows the key distinctions between cross-sectional and longitudinal surveys.

<b>Cross-sectional surveys</b>	<b>Longitudinal surveys</b>
<ul style="list-style-type: none"> <li>• Methods observing a collection of people at one time (Neuman, 2006).</li> </ul>	<ul style="list-style-type: none"> <li>• Methods which tell us about change at the individual micro level since the data are collected from and about the same people at different time points (Menard, 1991; Ruspini, 2002).</li> </ul>
<ul style="list-style-type: none"> <li>• Provide measures of net change (change at the aggregate or macro level at one or a series of time point) (Kalton, 2004; Rose, 2000).</li> </ul>	<ul style="list-style-type: none"> <li>• Provide measures of gross change (change at the individual or micro level) (Kalton, 2004; Rose, 2000).</li> </ul>
<ul style="list-style-type: none"> <li>• Provide data indicating what is associated with what (correlation) (Gomm, 2000). In health related areas, for example, cross-sectional surveys provide a cost-effective aggregate, and a cross-sectional view of a population's health status, health care access, utilization and expenditure experience (Ezzati-Rice and Cohen, 2004).</li> </ul>	<ul style="list-style-type: none"> <li>• Provide an understanding of processes, causes and effects in relation to trends and social changes (Rose, 2000). In health related areas, for example, a longitudinal survey is used to provide the precursors of health outcomes and possible cause-effect relationships for health policies in rapidly changing health care scenarios (Kalton, 2004; Ezzati-Rice and Cohen, 2004).</li> </ul>

To conclude, the key advantages of longitudinal research designs lie in their capability:

- to catch the temporal dimension by linking individual data across time;
- to provide repeated measures over time for the same individuals, families and households; to explore macro and micro interconnections;
- to provide possible cause-effect relationships in relation trend and social changes; and,
- for policy-makers, longitudinal survey offers proper understanding of the dynamics that underlie the research issues to tackle the problems more effectively.

### **Utility of Longitudinal Studies for Population and Health**

Classic examples of longitudinal studies and their utility come from Europe and North America. Using data from the Panel Study of Income Dynamics (PSID) for the USA and Dutch survey data, Muffels (2000), Jarvis and Jenkins (2000), and Ashworth, Hill and Walker (2000) revealed that transitions into and out of poverty are temporary rather than long-term, and that only a small proportion of poverty is intergenerational. These findings illustrate one area in which the potential of longitudinal data contributed to the development of social science and social policy (Duncan, 2000; Rose, 2000).

The British 1946 National Birth Cohort Study is well known as a longitudinal life course study, which began at the birth of its sample members in 1946 and continues still (Rose, 2000; Ruspini, 2002; Wadsworth, 2004). The data set has been of great policy value in the development of health and education services through its prospectively collected data that show health or attainment before and after interventions (Wadsworth, 2004).

The British Household Panel Study (BHPS) is another example of good practice, since it was designed after other Panel Studies were carefully examined. The main aim of the survey is to study economic and social change in Great Britain at individual and the family levels (Rose, 2000; Ruspini, 2002). The BHPS has proven to be an important resource for academic and policy-related initiatives into income dynamics and poverty alleviation (Ashworth, Hill and Walker, 2000; Jarvis and Jenkins, 2000).

In addition to these classic examples, longitudinal studies have also been used for several other purposes in population and health.

- Longitudinal panel samples have been used to develop predictive models (Kalton and Citro, 2000). Ezzati-Rice and Cohen (2004), for example, developed predictive models for determining medical care expenditures for a total population and for population subgroups using longitudinal panel samples. Similarly, Kasprzyk and Pascale (2004) and Wolfson and Rowe (2004) have noted that joint patterns of disability levels and the potential availability of informal support for future elderly can be estimated and projected using longitudinal data, along with simulated cases.
- Schroots (1993) utilized longitudinal research to measure adult health trends and to identify patterns of aging in populations and individuals.
- Longitudinal panel samples can also be used to measure gross change and to assess the effectiveness of health interventions (Kalton and Citro, 2006). Sirirassamee et al. (2007), for example, used their longitudinal data on the Tobacco Control Policy in Thailand (Waves 1 and 2) to measure gross changes in responses and to evaluate the effectiveness of the policy and the graphic warnings labels, in particular.
- Longitudinal research has also been used to examine relationships between variables across time (Kalton and Citro, 2000). Case and Ardington (2006) used longitudinal data in which the same children were followed through time with parents' deaths recorded as they occurred in order to evaluate explanations for child outcomes following the death of a parent.
- Longitudinal data can also be used in the estimation of spell duration (Kalton and Citro, 2000; Ruspini, 2002). Using data from Waves 1 and 2 of the National Longitudinal Study of Adolescent Health, Brown (2006) examined the influence of parental marital and cohabitation transitions on adolescent delinquency, depression, and school engagement. Longitudinal data allowed the author to analyze the transition into and out of cohabiting step-families and how they compared not only to marital transitions but also to various stable family forms in their effects on adolescent well-being.

Longitudinal studies, therefore, have been widely used in population and health research. Currently, though, two major scenarios are of particular importance for longitudinal studies. One is in countries that lack vital registration systems and comprehensive sources of information on the demographic and health of their populations. In these situations, longitudinal studies have been crucial (WHO, 2006).

Another area of special importance encompasses studies that require a proper understanding of social and population dynamics or micro-social change. As Lazarsfeld (1940 cited in Ruspini, 2002) has stated, “the panel technique seems to be one of the promising tools for the future in gaining a fuller understanding of human behavior”. Ruspini (2002) echoes this statement clearly while mentioning that cross-sectional studies do not reveal whether any changes that show up should be attributed to new individuals entering or to a real change in behavior. Longitudinal (panel) studies resolve this problem as they offer researchers opportunities to re-interview the same respondents again and again. This makes them an indispensable tool for the analysis of social change.

### **Longitudinal Research in the Asia and Pacific Region**

In the late 1970s, a population surveillance system was established in the Matlab district of Bangladesh. This surveillance system has provided data that have allowed researchers to gain a much fuller understanding of the dynamics of family planning and child survival (Arends-Kuenning, 2002; Bairagi, 2001; Levin et al., 1999; Phillips and Hossain, 2003). A number of other surveillance systems in the Asia-Pacific Region were established thereafter; for example, the Australian Longitudinal Study on Women’s Health, University of New Castle, Australia; The Moving Out of Poverty Study, Cambodia; Longitudinal Research in Population and Development in China; The Vadu Rural Health Project, KEM Hospital, Pune, India; Purworejo Demographic Surveillance System, Indonesia; Longitudinal Research in Aging, Nihon University, Japan; The Population and Family Survey in Malaysia; The Cebu Longitudinal Health & Nutrition Survey, Philippines; The Kanchanaburi Demographic Surveillance System (KDSS), Mahidol University, Thailand<sup>1</sup>; and the Chililab Demographic Surveillance System (DSS), Haiduong, Vietnam.

The longitudinal studies in Asia-Pacific Region discussed below are no doubt far from comprehensive, yet they reflect the growing need for and prevalence of longitudinal research in the Region. They were obtained through an Internet search of studies conducted in the last five years as well as the ones submitted to the conference. For the sake of simplicity, they can be grouped under the following themes: Contraceptive use and fertility; Migration, health and well-being; Children’s health and development; Health and development; and Poverty.

### Contraceptive Use and Fertility

Contraceptive prevalence in Bangladesh has been increasing due much to the doorstep delivery of contraceptive methods (Bairagi, 2001; Oliveras, 2007). But for the last 6-7 years, the total fertility rate has remained at 3.3 livetime births per woman (Bairagi, 2001). Three papers from Bangladesh assessed the possible factors affecting contraceptive use dynamics and fertility levels, namely, characteristics of community health workers, reversal strategies of programs, and son preference.

Islam, Barua and Bairagi, (2003) analyzed contraceptive use dynamics, prevalence, continuation and failure using individual records from the Matlab DSS database as well as data from the evaluation study of community health workers' performance. Multivariate logistic regression and multivariate hazards regression revealed that the characteristics of community health workers significantly affected the contraceptive prevalence rate, as well as continuation and failure of contraceptive methods. These characteristics, such as enthusiasm, regularity in work, and conformation to social norms, had a significant positive effect on contraceptive prevalence and continuation, but a negative effect on method failure. It was recommended that these characteristics be used as recruitment criteria in order to reduce the failure rate and, in turn, bring down the fertility level. Training curriculum should also be designed to change the attitudes and behaviors of fieldworkers to be in line with positive characteristics.

Oliveras (2007), however, argues that family planning programs might also be affected by government strategy reversal. Using the same longitudinal dataset from ICDDR,B from 1982-2005 and supplemented by data from special studies, she explored the impact of changes in the contraceptive delivery strategy in Bangladesh on levels of pregnancy termination and its role on fertility decline. Through an analysis of changes over time, she has shown that changes in abortion rates coincided with changes in the contraceptive delivery strategy, which suggested an impact of the reversed strategy. Her finding implies the role of better family planning programs in limiting abortion rates.

Similarly, Bairagi and Saha (n.d.) investigated the reasons for the contradiction between abortion and contraceptive rates by using selective measures limited by a paucity of detailed data on abortion from the Matlab DSS for the period of 1978-1998. A comparison of the abortion rate, the contraceptive prevalence rate (CPR), desired

fertility, and the total fertility rate (TFR) over time formed the basis for the study. Results showed that desired fertility declined over time. Fertility was converging to the desired fertility, and the process of convergence was faster in the MCH-FP area. The relationship between the CPR and the total abortion rate (TAR) was positive, negative and zero during the convergence. The magnitude of abortion depends on the quality of reproductive health services. A comprehensive MCH-FP program is expected to bring down both fertility and abortions substantially by increasing contraception.

Bairagi (2001) also used data from the Matlab DSS to investigate the effects of son preference on contraceptive use, abortion and fertility, as well as trends in these over time in the Matlab maternal and child health and family project area and in a comparison area. A modified Arnold Index was used to estimate an increase or decrease in contraceptive preference, abortion and fertility that would occur in the population in the absence of son preference. The level of sex-selective abortion was measured by the deviation from the expected ratio of males to females at birth. The author concluded that sex preference does not have a strong effect on contraceptive use in Matlab. Its absence, however, would probably increase recourse to abortion, which is used to limit fertility once couples have the number of sons they desire. The effect of sex preference on childbearing is becoming stronger as fertility declines, because couples must achieve their desired number of sons within a smaller overall number of children. Policy makers thus need to determine how to reduce both son preference and recourse to abortion in Bangladesh.

Studies from Sri Lanka and Malaysia focus on analyzing fertility trends and differentials in order to provide evidence to guide policy development and as a means to make realistic fertility assumptions for population projections.

In Sri Lanka, lower fertility among estate women since the 1940s was associated with poor nutrition and diet that could delay age at menarche and cause “secondary sterility”. Consequently, government programs have been under way since the 1970s to improve the living conditions of this population group. In 2002, Puvanarajan analyzed fertility trends and patterns of estate women using the 1975 World Fertility Survey, the Sri Lanka Population Census from 1946 to 1981, statistics for 1957-1981 from the Registrar General’s Department, and results from the 1987 and 1993 Demographic and Health Surveys. Several case studies were conducted to establish causal links with respect to their reproductive capabilities. The author concluded that the total fertility rate of the estate sector is increasing while other

population groups are declining. This signals their higher nutritional levels, which contributes to improvement in their reproductive capabilities, and consequent on the successful implementation of programs directed at their well-being. In this regard, it would be beneficial to adopt family planning policies which target to lower fertility levels.

In Malaysia, fertility transition also varies significantly across the various ethnic groups (the Malays, Chinese and Indians). Peng (2007) used The Malaysian Population and Family Surveys (1967, 1974, 1984, 1994 and 2004) to examine the fertility trends and patterns of various ethnic groups using both cohort and period measures. Multivariate areal analysis of the correlates of period fertility was conducted using vital registration and census data. The socioeconomic correlates of fertility and its proximate determinants were analyzed using the survey data. In addition, the fertility estimates based on the period and cohort measures were compared to gain a better understanding of the tempo distortion of the level of fertility. The results from this analysis will provide a better basis for making fertility assumptions for population projections that will be used in development planning.

Fertility intention and subsequent childbearing have been explored by a study from Thailand. Using the Kanchanaburi DSS, Hongxia (2007) drew upon parts of the fertility data to explore the relationship between fertility intentions, socio-demographic factors and subsequent childbearing. All married women who were born from 1955 to 1985 were followed from August 2001 to August 2004 and their pregnancy histories were recorded on a monthly basis during this period using Laing's Calendar. Women who were pregnant before August 2001 and women who were infertile were excluded from the study. Event history analysis was used to identify the probability of having a child among women who reported that they wanted no more children or at least one more child during the study period. Life table and Cox Regression techniques of EHA were used to examine the timing of giving birth. The results indicated that subsequent childbearing is more likely among women who are younger, who delayed childbearing, who have only one child, or who have three or more daughters. It is suggested that pro-natalist policies should facilitate the women who would like to give birth rather than focus on only changing their attitudes to having children.

Overall, these studies utilized longitudinal data *to generate accurate cohort data on changes* in contraceptive use and determinants; abortion and its role in fertility; as well as fertility trends and patterns; and *to develop a predictive model* on fertility

intention and subsequent childbearing. The authors either use only longitudinal data sets (i.e. Bairagi, 2001; Bairagi and Saha (n.d.); Hongxia, 2007), a combination of longitudinal data and other surveys (i.e. Islam, Barua and Bairagi, 2003; Oliveras, 2007; Peng, 2007) or record linkages (Puvanarajan, 2002) to generate such changes.

### **Migration, Health and Well-being**

Although modernization theory attests that migration and urbanization would lead to a breakdown in familial support for the aged, a study from Bangladesh does not support this theory. Using results from the 1996 Matlab Health and Socioeconomic Survey (MHSS) in an area of Bangladesh that is also the site of Demographic Surveillance program conducted by ICDDR, B, Kuhn (2003) examined the impact of child migration on the health and survival of a cohort of respondents age 50<sup>+</sup> by linking detailed household and health survey data to event records. The results of this study show that children's migration does not have a deleterious impact on the elderly. On the contrary, it has a strongly positive effect on their health and mortality.

Evidence from rural China also supports Khun's findings for Bangladesh. The impact of intergenerational exchanges on health (Song, Li and Feldman, 2007) and on cognitive functioning (Ping and Shu-Zhou, 2007) of rural Chinese elderly was examined using two different sets of longitudinal surveys. The authors found that children's migration with intergenerational support and financial transfers led to an increase in the health and cognitive functioning of the elderly. The study of migration in Kanchanaburi DSS, Thailand from 2000 to 2004 confirmed that migration is likely to have added to the economic viability of the households (Punpuing and Guest, 2006).

Also focusing on children's migration and its effects on the elderly, Min and Punpuing (2007) used the same dataset from the Kanchanaburi DSS to generate information on changes in the living arrangements of elderly persons as affected by child migration. Based on survival analysis, the results provided evidence that living arrangements among the elderly in the KDSS remained relatively stable over the four-year period. Annually, though, the proportion of older persons who live alone or who live with spouses has been increasing slightly, while that of those who live with at least one child has been declining.

Jampaklay (2006), however, noted that adverse effects arise when the parents move. Using longitudinal research data from the Kanchanaburi DSS, the author

examined the relationship between parental absence due to migration and children's school enrollment. Her results suggested that the length of absence matters differently for fathers and mothers. While a short-term absence of the father reduces the children's chance to enroll, a long-term absence does not. The long-term absence of the mother, however, appears to reduce the educational chances of children left behind. The results suggest that maternal roles are not easily replaced by other family members. The study also shows the contrasting role remittances play as a contribution to education for children left behind and as a motivation to migrate for children who have already left school.

This section has dealt with persons 'left behind' due to either child or parental migration. The authors of these studies use longitudinal data to *examine the relationships between variables across time*. As Buck (2000) puts it "longitudinal research makes it possible to focus on the migration process and its relation to the household formation process as well as causal explanations." The results of the studies from Bangladesh, China and Thailand reveal that child migration seems to have positive benefits for the elderly, while parental migration has a negative impact on children.

### **Children's Health and Development**

Two prospective cohort studies from birth to adulthood have been undertaken in the Region – one in the Philippines and another in Thailand, both of which are providing a wealth of information on children's health and development. In the Philippines, the Cebu Longitudinal Health and Nutrition Survey (CLHNS) was started in 1983 with the objective of understanding infant feeding practices, determinants and consequences of infant feeding and maternal and child health practices and the effects of ecological factors (household and community environment) on birth and health outcomes. The CLHNS used a stratified single stage cluster sampling procedure to select 33 barangays (i.e. 17 urban and 16 rural barangays) from Metro Cebu from which a cohort of pregnant women were included in the study. Stratification was by urban rural residence and the barangay served as the cluster. Infants born between the period of 1 May 1983 to 30 April 1984 and their mothers served as the baseline sample of mother and child pairs.

A total of 3,327 women and their offspring formed the mother infant pairs that were the focus of the study. A 12-month birth cohort was used to account for seasonality as a possible determinant of child growth, morbidity, mortality, maternal

fertility and nutritional patterns (Adair and Popkin, 2001). As part of the design, data were periodically collected on all infants born in the sample barangays and their mothers until the infants were 24 months old. Interviews with mothers and child histories were undertaken immediately after each birth, then at two-month intervals for twenty-four months. It was critical to collect data on the mother and child within a day or two of each child's bi-monthly birthday over a two-year period to capture the sequence of feeding events, the dynamics of breastfeeding and other feeding behavior and the factors affecting feeding decisions at each point in time (Feranil, Gultiano and Adair 2007).

The Longitudinal Cohort Study of Thai Children and Families (PCTC) aims at tracing the development of Thai children from fetus to young adults in order to acquire key knowledge regarding children's growth and other developmental outcomes and their determinants. PCTC began its recruitment for a cohort of children in 2000. Women in the 28<sup>th</sup> week of pregnancy were enrolled at five sites in different parts of the country to ensure a diverse sample (N = 4,200). The study followed the children before birth, at birth, and then by interviewing mothers at home at 1 month, 3 months, 6 months, and 1 year after birth. Subsequently, researchers have conducted follow-up every 6 months. Data were collected about each family's lifestyle and nutrition, using 3-day and 7-day diary self-report records. The overall plan for the project is to follow the cohort for 24 years (Choprapawan, 2007).

One major concern in the area of children's health is infant and under-five mortality. To reduce child mortality is one of the eight Millennium Development Goals that each country is to achieve (Vapatanapong, 2005). Longitudinal data from the Kanchanaburi DSS was used to estimate the under-five mortality rate (U5MR) of the project's population by applying the Trussel version of the Brass Method. The analysis suggests that the high U5MRs during the 1980s have gradually declined, both in males and females. Currently, the U5MR of people in Kanchanaburi Project is approximately 20-30 per thousand, which is similar to the national rate (Vapatanapong, 2005).

Status of breast-feeding and its role in infant morbidity and mortality is well-established. In Bangladesh, results from a longitudinal study on breast-feeding practices in two rural areas revealed that, irrespective of study sites, a significantly higher proportion of infant deaths occurred among non-exclusively breastfed infants compared to those who were exclusively breastfed infants at six months of age. In each year, significantly lower proportions of infant deaths were reported among those who

continued breastfeeding after six months of age. This study thus confirms a significant association between status of breast-feeding and infant deaths (Gazi et al., 2007). Evidence from the same dataset (1993-2004) suggests further that females experience higher mortality than males, especially during childhood (1-4 year age group). This is indicative of the gender-biased behavior of discriminating against female children. This study concludes that effective policy interventions to ensure equality between males and females are needed (Islam, 2007).

Mo-suwan et al. (2007) have investigated prolonged breast-feeding and its determinants by using the Prospective Cohort Study of Thai Children (PCTC) conducted in five areas of Thailand. Data were collected by interviews at 21 ( $\pm 3$ ) days (with a recall back to birth), at 6 months, and then every 6 months thereafter. Information obtained from the interviews included infant feeding practices, maternal age, education level, occupation, religion and family economic status. Infants were also weighed at birth, at 6 months and then every 6 months thereafter. Weight status was classified using the WHO Reference as underweight if having weight-for-age less than median -2SD. Logistic regression was used to explore factors associated with prolonged breast feeding practices. The initial cohort comprised 4,245 live births. After omitting twins and subjects with incomplete follow-up on body weight, the study sample comprised 3,125 children. About half (54.1%) of mothers breast fed their babies longer than 12 months. Prevalence of underweight in children at 6 months and 12 months were 2.7% and 14.0%, respectively. Findings from this study showed that breast feeding longer than 12 months was related to the weight status of infants during the first year, maternal factors and family economic status. The authors recommend that further studies should be carried out to investigate the outcomes of this practice with regard to growth during the second year.

Maternal deaths also have a significant impact on infants. A study in India revealed that maternal deaths accounted for 13% of all deaths among reproductive-age women, and that live born infants of deceased mothers had a markedly higher risk of dying in the first year of life (Ganatra, Coyaji and Rao, 1998). A total of 121 maternal deaths, identified through multiple-source surveillance in 400 villages in Maharashtra, were prospectively enrolled during 1993-1995 in a population-based case-control study comparing deaths with the survivors of similar pregnancy complications. Mothers who died took significantly longer to seek care and to make the first health contact after deciding to seek care. They also traveled significantly farther through more health facilities before appropriate treatment was started. Multivariate analysis showed the

negative effect of excessive referrals and the protective effects of living in, rather than away from, villages, having a resident nurse in the village, having an educated husband and a trained attendant at delivery, and being at the woman's parents' home at the time of illness. The authors recommend information-education-communication (IEC) efforts to increase family preparedness for emergencies, to decentralize obstetric management with effective triage, and to restructure the referral system.

Among school children, a major health concern is intestinal worm infection. In Indonesia, the prevalence rate of this infection among school children is 60-80%. In order to decrease the prevalence rate, a school-based parasite control program was established in Jakarta. In this program, health education was conducted among students, teachers and parents. Mahasawati (2007) used a longitudinal data set (1987-2006) to establish the cost-effectiveness of the school-based parasite control program, as well as to identify the need for new interventions to improve health status of the primary school children in Jakarta. Twice-a-year stool collection was also conducted to identify infected students as a basis for providing antihelminthic drugs for treatment, to determine the type of worms causing the infections, as well as to determine the overall prevalence rate of infection. Data also revealed changes in the fertility of intestinal worm eggs. In the beginning, the percentage of both fertile and infertile eggs was high, though that of fertile eggs was higher than for infertile eggs. By sustaining the program, the percentage of both fertile and infertile eggs decreased. After three consecutive years, the proportion reversed to that of a higher percentage of infertile eggs, which helped to decrease the re-infection rate. The low prevalence rate of intestinal worm infection as a result of the sustained program prompted researchers to initiate a new type of program in 2000. Blood examinations were conducted among more than 5,000 students, and the results showed a high prevalence rate of anemia. An anemia control program is now being conducted to improve the health status of the students.

These longitudinal as well as cohort studies have proven to be valuable in the area of children's health and development. The strength of these designs is in their information on sequence and chronology, which has enabled researchers *to analyze the relationship of earlier experiences with later health outcomes*. Findings from the breast-feeding studies in Bangladesh and Thailand as well as the study of maternal deaths in India yield significant insights for policies and services to improve children's and maternal health. In Indonesia, longitudinal data were a valuable tool to improve the health status of primary school children through evaluating the school-based parasite

control program as well as identifying new interventions. Longitudinal data can also provide the parameters (*i.e. infant and under-five mortality*) for estimation.

### **Health and Development**

Formulation of health policies and programs depends on knowledge and information on prevailing health trends, on underlying social and behavioral dynamics, and on valid measures of morbidity and mortality. In this section, prevailing health trends are highlighted through four studies from Australia, Philippines, Thailand and Vietnam. The study in Australia is on women's health, while the others are on the health of the elderly.

#### ***Health trends***

Women's health in Australia has been examined using the data set from The Australian Longitudinal Study on Women's Health (ALSWH). Findings illustrate important trends in women's health (e.g., the prevalence and incidence of chronic conditions, including heart disease, hypertension, osteoporosis, diabetes, asthma and arthritis) among all three cohorts, thus providing information about health trends among younger, middle-age and older Australian women over the past ten years. Risk factors for chronic conditions were also examined, including Body Mass Index, physical activity, tobacco and alcohol use, and education level. The study has provided invaluable data about the health of women as they age (Byles and Dobson, 2007).

Cruz and Agustin (2007) using the Philippine Elderly Survey (PES) have examined health transition patterns and the factors that determine these transitions. Functional health analysis revealed that aging does not necessarily imply a continuous decline in health. In fact, it indicates a significant movement in and out of one's initial health. There is particular evidence of recovery from inactive status which needs to be taken into account if a more realistic estimate of functional health transition is to be achieved.

A longitudinal study on health, aging and retirement in Thailand is also underway as a new approach for policy formulation concerning the well-being of the elderly in an aging society. The goal is to improve the quality of life of the elderly. Major elements, such as labor supply, health, medical care, and long-term care for the elderly, will be investigated (Anantanasuwong, 2007).

In Vietnam, Nguyen (2007) has conducted a study that explores trends and factors associated with nutritional status among aging Vietnamese. The study is designed as an early warning mechanism to identify changing health trends that result from changes in nutritional status among aging people and their associated factors. This information will be valuable for policy makers. The study is based on three National Surveys of Socioeconomic Factors and Health conducted over a 10-year period, namely: the Vietnamese Living Standard Survey 1992-93; the Vietnamese Living Standard Survey 1997-98; and the Vietnamese National Health Survey 2001-02. Respondents aged over 45 years were stratified by sex, age group, area of residence, household expenditures, and some health consequences. Chronic energy deficiency (CED) and overweight were assessed. Obesity was defined using body mass index (BMI) at cutoffs 18.5 and 23 kg/m. Results of the study suggest a double burden of disease in the aging Vietnamese population in that both CED and overweight exist, along with their related health consequences. This double burden of disease is a common characteristic of countries in this phase of the nutrition transition. Moreover, the decline in lean body mass among older people is thought to cause these changes and should be addressed by public health policy.

#### ***Social and behavioral dynamics***

The studies focusing on understanding the social and behavioral dynamics of certain health threats are from Bangladesh and Indonesia. The study from Bangladesh has shown how a Demographic Surveillance System can be used to periodically monitor risky behaviors among migrants and assess their vulnerability to HIV/AIDS. The Longitudinal DSS database of ICDDR, B covering 33,000 people in Abhoynagar/Keshobpur sub-district and 39,000 in Mirsarai sub-district was used to identify men who migrated, both internally and externally, during 1999 to 2004. A cross-sectional survey was conducted from October-December 2004 to assess the prevalence of risky sexual behaviors among 703 married male migrants. Their responses were compared to those of married men who had not been separated from their spouses. The results showed that among married men, about 60% who had lived away from their wives in Bangladesh and 67% of those who had lived abroad had extramarital sex. Less than one-third of these men ever used a condom during sex either with a sex worker or during marital sex.

Given the practical difficulty of locating migrants among the general population and the social stigma attached to HIV, the scope for expanding surveillance

to monitor their sexual behavior is limited. As evident from this study, however, the availability of a longitudinal database provides an opportunity to track migrants and investigate their sexual behaviors. *Systematic, periodic monitoring of the sexual behavior of migrants in the longitudinal surveillance system would provide added value to the surveillance system, and the results would be extremely valuable for modifying an intervention program*, including VCT and awareness-raising for prevention of HIV/AIDS (Khanam, Ashraf and Mels, 2007).

In Indonesia, an on-going qualitative longitudinal study on drug abusers in Jakarta is being conducted (Suci, 2007). The study aims to better understand the behavioral, social and cultural patterns of drug abusers and their reasons for relapse and drop out (from rehabilitation centers), as well as to evaluate the programs in rehabilitation centers based on clients' perspectives. This three-year longitudinal qualitative study is being conducted among 35 respondents (28 males and 7 females) who live in the Jakarta Metropolitan Area. They are evaluated every four months for two years. Preliminary analysis reveals that most of the respondents use marijuana and hashish, which they obtain mainly from friends. They also did not intend to use it seriously, and they believed that a drug like hashish has minimal side effects so that continued use would not cause harm.

#### ***Health risk, morbidity and mortality***

In Thailand, Seubsman, Sleigh and the Thai Cohort Study Team (2007) are investigating a valid measure for health-risk transitions. A national cohort study was initiated comprised of a large cohort of Sukhothai Thammathirat Open University (STOU) students. These students were recruited in 2005 when a questionnaire was mailed to all 200,000 STOU students. The questionnaire asked about the respondents' social demography, living environments, current incomes, occupations and work circumstances, overall health, health service access and use, use of tobacco and alcohol, and transport. By early 2006, 87,134 had responded, initiating the Thai Cohort Study. A follow-up will be done in 2008.

Data on death are crucial and fundamental for a valid measure of mortality. According to Prasartkul et al. (2007), the demand for more complete and higher quality data on the causes of death is rising in every developing country including Thailand. This need has inspired many researchers to seek out methods that could improve the quality of mortality data. Recently, the "verbal autopsy" (VA) methodology has been

tested in many countries, such as India, China, Tanzania and Ethiopia (Chandramon et al., 1998; Gajalakshmi et al., 2002; Khan et al., 2000; Ministry of Health, 2001; Quigley, Amstrong and Snow, 1996; Yang, 2005). VA is a technique to identify the cause of death through retrospective interviews with a relative or caretaker of the deceased person.

Prasartkul et al. (2007) has conducted a special study on verbal autopsy for all ages of death in both urban and rural areas of Kanchanaburi province as an integral part of the Demographic Surveillance System from 2002-2003. The aims of the study are:

1. To develop a VA instrument using data-derived algorithms and to test its utility in determining the specific cause of death in Thai settings, and
2. To transform the VA tool into a computer program as an alternative to a voluminous paper questionnaire.

To date, the computer program has been developed and patented under the name “The Mahidol Autopsy System” to obtain valid information on causes of death. In the long-term, it is hoped to be used in the routine death registration system.

In summary, this section has dealt with the value of longitudinal data in contributing to the formulation of health policies and programs by *ascertaining health trends; generating accurate cohort data on changes in morbidity; serving as a periodic monitoring tool for risk behavior; and for developing a computer program as a tool to obtain valid information on causes of death.*

### **Poverty**

In Cambodia, the longitudinal Moving Out of Poverty Study was designed to use both quantitative and qualitative research techniques. So (2007) has used this panel data set to analyze household dynamics and household movement in and out of poverty. Findings from this study provide valuable information on poverty assessment and the recognition that growth is not necessarily correlated with poverty reduction. Rather, it increases income inequality, accelerates social stratification, and poses a greater challenge for governments to halt poverty. Movement out of poverty is substantial, but unstable, especially for female headed households who have fewer income earners, higher consumption levels and less savings to cushion against shocks and family crises. The author concludes that the challenge for poverty reduction in Cambodia will depend

on the success of broadening economic development to rural areas and securing rights of access to common property resources for the poor.

Studies from Thailand also uncovered a similar pattern. Using the Kanchanaburi DSS, Viswanathan and Thongthai (2007) analyzed longitudinal trends in gender segregated occupational patterns and the inequalities in income distribution in the KDSS sites for the period 2000 to 2004. Gender differentials in earnings were highly significant. The earnings gap between males and females is on the rise. From the same data set, Sunpuwan (2007) explored the relationship between household headship and wealth accumulation. She found that the households which are headed by males are more likely to be better off than female headed households. However, the presence of other work contributors and migration aid in improving the ability of the household to accumulate wealth in terms of housing and modern goods. Ford, Rukamnuaykit and Kanchanachitra (2006), using the same data set of Kanchanaburi DSS, indicate clearly that the death of a household head of working age, irrespective of sex, would hamper family income.

The authors of these four studies attempt to analyze the dynamics that underlie the issues of poverty using longitudinal datasets. Their findings are of particular importance for the development of poverty alleviation policies and are also quite different from those in other continents, i.e. Europe and North America.

In conclusion, currently the contributions of longitudinal studies in the Asia-Pacific Region have centered on such areas as contraception, fertility, child survival, and the health of adults and the elderly. Analytical utility has focused on measuring gross change, examining the relationship between variables across time, developing a predictive model, and developing a tool to get valid vital data. The information obtained from longitudinal studies is not only valuable for academics but also for policy-makers as well as practitioners. However, much more needs to be done to improve and to expand the utility of longitudinal research for improving population and health in Asia-Pacific Region.

### **Future Prospects and Challenges for Longitudinal Research**

In this paper, we have argued for the importance of longitudinal research in addressing many of the major issues in research in population and health. For too long

social and public health research has relied on correlational analysis where a confounding of temporal relationships has meant that it has been difficult to conclusively establish cause-effect relationships. It is clear that well-designed longitudinal studies can provide the data necessary for researchers to undertake the complex statistical analyses that are required to support claims of cause-effect relationships. Longitudinal studies that follow the same persons over time also have an advantage of illustrating the complexity and transitory nature of human behavior over time.

While the need for longitudinal research is well-established, several challenges can potentially reduce the likelihood that there will be a large-scale shift to longitudinal research designs in the Asia and Pacific Region in the near future. We would like to highlight three inter-related challenges: complexity of conducting research, cost of research, and the capacity of researchers.

High quality longitudinal research requires a large investment of resources. A major threat to the validity of findings from longitudinal research is loss-to-follow-up. There is a need to minimize this loss and this requires that major efforts be allocated for tracing members of the population to be followed-up. Where migration rates are high, or where other factors operate to make follow-up difficult, the resources required become even greater. Other factors that lead to increased use of resources are the need to maintain permanent data collection staff, the need for high quality data entry and processing staff, and maintaining an on-going research and administrative staff. Since many of the benefits of longitudinal research are not attained until after several years of data collection, it is often difficult to convince donors of the need to invest large amounts of money over relatively long periods of time. Without the support of major donors for longitudinal research designs the prospects for longitudinal research are dim.

As can be seen from the discussion on cost above, longitudinal research designs are complex. This complexity pervades every aspect of the research, from how to maintain community interest, to the instruments used, to ethical issues, to how to link households and individuals, to how to create an easily accessible data base, to how to undertake analysis, to how to report analysis. The complexity of longitudinal research often leads to researchers either choosing cross-sectional designs over longitudinal designs, or treating data from longitudinal research designs as if they were derived from cross-sectional designs. While there is no way to eliminate the complexity of

longitudinal research, there are ways to reduce the complexity. Learning from others through membership in networks, such as the INDEPTH network, will help organizations understand and conform the complexity of longitudinal studies.

Building the capacity of research staff is required to enhance the prospects of longitudinal research in the Asia and Pacific Region. Most of us have been trained in cross-sectional research. Our methods of collecting data, of entering data, and of analyzing data are directed to surveys done once, not repeatedly over an extended time period. We all need different skills to effectively implement and take advantage of longitudinal research designs. Increasingly, there is awareness of this need. For example, INDPETH is supporting a special Masters course in South Africa related to longitudinal research. But more needs to be done in this area if we are to take full advantage of longitudinal research now and in the future.

### **Note**

1. Kanchanaburi Demographic Surveillance System (KDSS), Institute for Population and Social Research, Mahidol University, Thailand.

With support from the Wellcome Trust, the Kanchanaburi project began in January 2000. Kanchanaburi is a large province located in the western part of Thailand. The province shares a long border with Myanmar and contains a variety of ethnic groups and migrants, both documented and undocumented, from Myanmar. The province is also close to Bangkok and is the location for many industries. In addition, the province is a major producer of plantation crops and is one of the major tourist destinations in Thailand.

The 100 field site communities included in the DSS were selected to reflect this diversity in social, economic and ecological conditions found in the province. These communities are located in urban/semi-urban, rice, plantation, upland, and mixed economy areas. There are 20 villages/blocks for each area.

The primary objective of the DSS is to monitor population change within the Kanchanaburi field site. Changes in population are linked to changes in social, economic and environmental conditions. The effects of government policies and programs as well as non-government projects on the villagers living in the field site are also analyzed. Macro- and micro-level databases have been developed to meet the objectives of the project, with information being disseminated through reports,

conferences, workshops, a Web site, training programs, and ad hoc meetings. These databases include spatial and social data.

A central component of the project is the annual enumeration of all households in the field site communities. The Kanchanaburi DSS collects information on every household and individual aged 15 years and over in each village/block in the study area. The enumeration is conducted between 1 July and 15 August each year, commencing in the year 2000. Five annual censuses have been conducted thus far.

Three sets of data collection instruments – community, household, and individual – are used for every annual enumeration. The data collected include population, economic, social, and health-related information. Each household from which the data are collected is given a unique code that remains constant over each round of data collection. Community data are collected in terms of general village data, agriculture, occupation, infrastructure and transportation, education, environmental issues, communication, health and sanitation, and public health services.

The enumeration consists of two main components. In the first component, data on fertility, mortality, and migration are collected. The second component includes questions related to social, economic, health and environmental issues. The issues included in the enumeration in this component may change each year in order to maintain the survey instrument at an acceptable size and to respond to changing social and policy contexts.

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