Longitudinal Research Designs and Utility in the Asian and Pacific Region

The experience of the Asian and Pacific region shows a great diversity in longitudinal research designs, the findings of which are benefiting the understanding of health and demographic transformations and contributing to more effective policies, programmes and services.

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Longitudinal research, which includes panel research, is the term used to differentiate the methodology and utility of prospective studies from that of cross-sectional research. It describes not a single method, but a family of methods that measure change by linking individual data across time (Zazzo, 1967, cited in Menard, 2002).

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Longitudinal research is valuable for understanding the causes and effects of socio-economic changes stemming from globalization; and population trends associated with changes in morbidity, mortality and migration; as well as health and epidemiological transitions within countries, especially at the micro level, such as at the individual, family or community levels. In the field of health, for example, one prominent concern is how to measure a population's health accurately, especially when it is facing many dynamic social, economic and behavioural changes that affect health (Murray and others, 2002). For their part, policymakers need to understand the dynamics that underlie key development issues in order to address them properly at policy and service levels (Rose, 2000).

Longitudinal research designs have thus become essential research tools for understanding change. As Ruspini (2002) noted, since the data are collected about the same population at different points of time, longitudinal research is able to present information about what happened to a set of units (people, households, firms etc.) across time. In this way, longitudinal data can also help to clarify ambiguities in causal relations through the temporal ordering of events and experiences in people's lives (Scott, 1995).

In this article, the authors provide an overview of longitudinal research design and utility in the Asian and Pacific region which is partly based on the articles presented at the International Conference on Understanding Health and Population over Time, which was organized in Bangkok on 24 and 25 May 2007 by the Institute for Population and Social Research.

An overview of longitudinal research designs

Longitudinal research designs often combine both extensive (quantitative) and intensive (qualitative) approaches. They can also allow for cross-sectional or longitudinal data analysis (Kalton and Citro, 2000) and qualitative multiple-case study analysis (Yoddumnern-Attig and others, 2006).

In the Asian and Pacific region, longitudinal population surveillance systems were established in the late 1960s, the most prominent being the Ballabgarh site in Haryana, India, in 1965 (Kapoor and others, 2006) and the Matlab site in the Chandpur District of Bangladesh in 1966 (Razzaque, 2007). Matlab surveillance system data, in particular, have enabled researchers to gain a much fuller understanding of the dynamics of family planning and child survival (Arends-Kuenning, 2002; Bairagi, 2001; Phillips and Hossain, 2003). Several other surveillance systems in the Asian and Pacific region were established thereafter, and some of their designs can be classified under four major types: (a)

repeated cross-sectional survey or trend analysis; (b) panel design; (c) longitudinal community studies; and (d) record linkages or administrative panels.

Before describing them in more detail below, it is important to stress that, irrespective of their variety in focus, covering the individual, a group of individuals (cohort), households and communities, as well as record linkages, *it is individuals who are followed over time*. In household panels, for example, data about household dynamics come from individuals who are associated with the households and their families (Rose, 2000; Ruspini, 2002). Another shared feature is that, given the length of the research and the need for follow-up, all longitudinal studies ought to apply strict ethical safeguards and ensure confidentiality to protect the respondents. It is also extremely important that respondents understand the implications of the longitudinal design and that they be contacted repeatedly at regular intervals.

In relative terms, the appropriateness of the research design is judged and adopted based on the particular research problem (Menard, 2002), since each design has specific purposes, merits and disadvantages, as will become clear from the description of the previously identified four major types presented below. Awareness of their relative strengths and weaknesses is important in order to develop appropriate strategies for reducing problems and maintaining the benefits of the design.

Repeated cross-sectional survey or trend analysis

In a repeated cross-sectional survey design, *the same question is regularly asked over a period of time to a different sample population at each time interval.* This design is extremely common and is most favoured by descriptive studies that focus on identifying changing trends. Much of our knowledge of trends in demographic and health outcomes derive from repeated cross-sectional surveys. For example, Thailand's contraceptive prevalence surveys (CPSs) adopted this design. The data from five survey rounds were compared in order to measure changes in contraceptive use and the fertility of women aged 15-49 during the period 1978-1996. The results indicated a continued decline in the total fertility rate, although at a slower pace in later years (Chamratrithirong and others, 1997; Leoprapai and Thongthai, 1989).

This design's major strength lies in its ability to measure change at an aggregate level. Changes in survey estimates and trends reflect changing population characteristics and changes in population composition (Kalton, 2004). However, this design is much less useful when it comes to determining causal relations because events cannot be precisely ordered over time.

Panel design

In a panel design, *the same individuals or groups of individuals are repeatedly interviewed at regular intervals* often using the same questions. Although this general principle is practised, panel designs can vary in the way the panel is established, in the means to maintain sample characteristics and in the ways to reduce distortion through the loss of subjects owing to factors such as mortality, boredom, mobility and refusals. Major modes of panel design and their features include the following types of panel.

Rotating panels are usually established through probability sampling. *Individual panel members are rotated in and out of the panel where they are followed at a specified interval for a relatively short period of time. New members are added to the new sample at each successive wave*. Such rotation enables the original characteristics of the sample to be maintained and reduces the distortion caused by the loss of subjects. In addition, a major feature of the rotating panel design is its ability to combine the features of both panel and cross-sectional analysis (Ezzati-Rice and Cohen, 2004; Rose, 2000). In the United States of America, Ezzati-Rice and Cohen (2004) utilized a rotating panel to develop predictive models for expenditures on medical care, yielding important information on the persistence of high medical expenditure costs, the precursors of health outcomes and possible cause-effect relationships as correlated with rapidly changing health-care scenarios.

Split panels are established *through long-term panel members who are followed over time as well as through the use of an additional replenishment sample.* A replenishment sample is added at each successive wave to ensure adequate sample size and survey continuity (Menard, 2002). Because it is similar to the rotating panel, the split panel design can be combined with a cross-sectional study design (Kalton and Citro, 2000). Sirirassamee and others (2007) used this design in their longitudinal data on Thailand's Tobacco Control Policy (2005-2009) to measure gross changes in responses and to evaluate the effectiveness of the policy, including the use of graphic warning labels on packets of tobacco in particular. Study results indicate that, while some success is evident in reducing the use of tobacco, an increase in the use of hand-rolled cigarettes has also been noted, possibly due to their lower price and absence of a warning label. This shift in tobacco consumption suggests the need for strengthened campaigns to influence smokers of factory-made and hand-rolled cigarettes so that they will quit smoking or reduce their intake of tobacco.

Cohort panels are designed *to observe intensively people who share a common life event at two or more times*. Commonly used cohorts include birth cohorts, people who enrolled in a programme in the same year, people who are in the same age

cohort and people who retired in a one- or two-year time frame (Neuman, 2006). The main focus of the cohort panel design is on examining the cohort and its important features, not on specific individuals. Its strength lies in its ability to identify the temporal ordering of sample members' experiences and to analyse the relationships of earlier experiences with later outcomes (Kalton, 2004); for example, it can highlight the interaction between early life experience and adult outcomes, while its weaknesses are most notably in terms of its longevity and the fixed sample structure (Wadsworth and others, 2003).

For the cohort panel design, replacement does not normally take place, which can lead to a decline in sample size over time. To minimize sample loss and distortion, several strategies can be used, such as birth cohort, childhood, catch-up and middle-life strategies, while tracking strategies are fundamental to all (Wadsworth and others, 2003). The *birth cohort strategy,* as illustrated by Choprapawan (2007) in her study of Thai children and families, and by Feranil, Gultiano and Adais (2007) in their discussion of the Cebu Longitudinal Health and Nutrition Survey in the Philippines, entails collecting data starting at birth and continuing thereafter into adulthood. In the *childhood strategy*, as used by Avila (2007) to measure the impact of the absence of mothers on the development of Filipino adolescents, data collection starts in childhood and continues into adult life. The *catch-up strategy* entails collecting data in childhood and then again in adulthood, as noted by Dempster-McCain and Moen (1998). In a *middle-life strategy,* as adopted by Byles and Dobson (2007) in their presentation of the findings from the Australian Longitudinal Study on Women's Health, and Seubsman and others (2007) in their national cohort study of the Thai health-risk transition, follow-up begins with cohort members who are in middle life and retrospective data are collected about their earlier experiences.

Household panels are based on initial probability sampling of individuals or households drawn from a population in a given area and following this population over time. Repeated interviews are carried out at a fixed interval and pay particular attention to the behaviours of individuals, families and households over time (Ruspini, 2002). Often all adult members in the household (not only a household head) are also repeatedly interviewed in successive waves. *The aim is to discover what happens to the same subject over a certain period of time, thus making it possible to study microsocial change.* When individuals are studied over time, it is possible to explore the dynamics of individual and family behaviours as they are affected by economic, demographic and social changes as well as the strategies they use to respond to such changes (Anderson, Bechhofer and Gershuny, 1994; Ruspini, 2002; Scott, 1995). Often-cited studies from outside the Asian and Pacific

region are, for example, the British Household Panel Study, the German Socio-economic Panel and the United States Panel Study of Income Dynamics.

Longitudinal community studies

While the individual or household is the main focus of other panel studies, the longitudinal community study *concentrates on a community as a whole (a total population), covering every household and individual living in a well-defined location* (Mbacke and Phillips, 2007; Mehryar, Naghavi and Kasemipour, 2007; Razzaque, 2007). Complete registration of all households is essential to explore, prioritize and address community issues in a timely and equitable manner (Taylor, 1997). Repeated data collection is carried out at fixed intervals, depending upon the project. A community panel is established by following individuals and households in the same community across time.

The demographic surveillance system (DSS), or the continuous recording of all births, deaths and migrations (Baiden, Hodgson and Binka, 2006), is a major component of several longitudinal community studies. Design variations exist, however, owing to differences in fundamental objectives as well as approaches to population health.

DSS sites, such as the two Vietnamese field laboratories of Chililab in Chi Linh District of Hai Duong Province and Filabavi in Bavi District of Hatay Province, the Matlab site in Chandpur District of Bangladesh and the Purworejo site in Central Java, Indonesia, use a public health approach to develop intensive small-scale vital registration systems and to serve as a comprehensive source of demographic and health information for the populations under study. Such information can be used to identify solutions to major health and population problems. Continuous programme monitoring and evaluation can be accomplished through such a rich source of longitudinal evidence (Anh and others, 2006; Long and others, 2006; Mehryar, Naghavi and Kasemipour, 2007; Razzaque and Streatfield, 2006; Wilopo and others, 2006).

Thailand's Kanchanaburi Demographic Surveillance System (KDSS), in Kanchanaburi Province on the border with Myanmar, has instead used a social approach to understand the relationship between socio-economic and demographic changes and the health consequences of the population in the study area (IPSR, 2004). KDSS is a hybrid design. While adopting the main features of longitudinal community studies, it incorporates distinctive features of household panel studies. Although data are collected annually for every household, all adult members in a household are repeatedly interviewed in successive waves (Guest and Punpuing, 2003). By linking data at individual, household and community levels over time

(across survey rounds), changes at each of these levels can be identified, such as changes in economic or health conditions, changes in household and community structures and processes, as well as changes in individual outcomes.

No matter what approach a project uses, *the design of longitudinal community studies is aimed at exploring demographic and health events in the same community over a certain period of time.*

Record linkages or administrative panels

The most important feature of this design is the *linkage between longitudinal survey and administrative cross-sectional sequences.* Data items that are not collected primarily for panel purposes are linked with administrative records using specific personal identifiers. The value added by this particular design comes from the pooling of data from several sources, which enables researchers to resolve methodological shortcomings in an efficient manner (Ruspini, 2002; Trivellato, 1999).

An ongoing project on malaria prevention among the Karen[1] population in the upland area of Kanchanaburi Province is a good example of this type of design (Yoddumnern-Attig and others, 2006). The KDSS data gathered annually from 2000 to 2004 are linked with data from the malaria registration record administered by the Malaria Division, Department of Communicable Disease Control, Ministry of Public Health. Data analysis can produce incidence and prevalence rates that vary annually, as well as provide an understanding of possible cause-effect relationships that stem from social, economic and behavioural changes over time.

Utility of longitudinal studies in the Asian and Pacific region

Longitudinal designs are used widely in population and health research, especially for studies that require a proper understanding of microlevel changes. They can also serve as valuable tools for initiating, or strengthening, a comprehensive vital registration system, and as a source of vital demographic and health information for populations living in particular priority areas (Mbacke and Phillips, 2007; Razzaque and Streatfield, 2006; WHO, 2006). In addition to these broad frames, longitudinal studies have also been used for several other specific purposes.

Longitudinal studies can generate accurate cohort data for estimating changes in basic demographic and health parameters, such as birth rates, fertility rates, maternal mortality rates and infant mortality rates). An analysis of longitudinal data from Ballabgarh in India, Matlab in Bangladesh and the Primary Health Care Network of the Islamic Republic of Iran, for example, indicate

comparable patterns of change in basic demographic and health parameters, such as neonatal, infant and under-five mortality rates (Kapoor and others, 2006; Mahryar, Naghavi and Kasemipour, 2007; Razzaque and Streatfield, 2006).

Longitudinal data can be used to develop a tool to obtain accurate information for a valid measure of mortality. As an integral part of KDSS, Prasartkul and others (2007) developed a verbal autopsy tool and computer software program under the patented name of "The Mahidol Verbal Autopsy System", which enables users to obtain valid information on the causes of death in different settings.

Longitudinal panel samples can be used to ascertain the health trends of a population. Byles and Dobson (2007) have used longitudinal data on women's health in Australia to measure health trends. Overweight, with adverse long-term health consequences, has been identified as a major health problem among Australian women as they age. Similar evidence has also been found among the elderly in Viet Nam and the recommendations made for public health interventions (Nguyen, 2007).

Longitudinal data have been used to develop predictive models for providing elderly persons with support. Studies from Bangladesh, China, the Philippines and Thailand, for example, have focused on developing behavioural models to measure health transitions, cognitive functioning, living arrangements and care-giving patterns among the elderly. Evidence from China and Thailand indicate that changes in the living arrangements of the elderly, as triggered by child migration, might disrupt traditional types of care-giving for the elderly (Min and Punpuing, 2007; Ping and Shu-Zhou, 2007). When social and financial supports are examined, several studies showed that children's migration can have a positive impact on the health of the elderly (Kuhn, 2003; Ping and Shu-Zhou, 2007; Punpuing and Guest, 2006). Cruz and Agustin (2007) highlight an important issue based on their study of Filipino elderly persons, that is, a realistic health transition model needs to take into account movement into and out of one's initial health status.

Longitudinal data can be used to examine relationships between variables across time. In analysing KDSS data on parental absence owing to migration and children's school enrolment, Jampaklay (2006) noted that adverse effects arise when the parents move. In particular, her results suggested that the long-term absence of mothers appears to reduce the educational chances of children left behind, and that maternal roles are not easily replaced by those of other family members.

Longitudinal research can measure gross flows into and out of a particular state. For example, So (2007) used the Cambodian panel data set to analyse household dynamics and movements into and out of poverty. Study findings provide valuable information on poverty assessment and the recognition that poverty reduction will depend on the success of broadening economic development into rural areas and securing rights of access to common property resources for the poor.

Longitudinal panel samples can assess health intervention effectiveness and living standards. Oliveras, Nahar and Johnston (2007) used the Matlab database from 1982 to 2005 to explore the impact of changes in Bangladesh's contraceptive delivery strategy. In Indonesia, Pitoyo (2007), using longitudinal data from the Indonesian Family Life Survey, assessed the impact of the Asian financial crisis (1997-2000) on the living standards of a sample population. Results showed a mixed picture in terms of people's standards of living. Moreover, the argument that the crisis affected macroeconomic performance more than household and individual economics seems to be upheld by the study's findings.

Longitudinal data can be used to develop appropriate feedback models for community utilization. For example, Gray, Pleumcharoen and Suwannopakao (2007) used KDSS data to develop communication models through which the data could be practically and effectively used at community and beneficiary levels.

Conclusion

Well-designed longitudinal studies have been used in many ways in the Asian and Pacific region. The studies presented above reflect the growing need for, and the prevalence of, longitudinal research designs in the region. Worthy of particular note is the proliferation of longitudinal community research designs. Found across the region, these designs have devoted particular attention to documenting relationships in the field of population and reproductive health. Overall, longitudinal studies are providing the valuable data necessary to establish causal relationships, thus providing a much better understanding of how rapid social changes affect the health of individuals and populations. Because of their theoretical and applied relevance, the undertaking of longitudinal research designs should be encouraged, notwithstanding the challenges posed by their complex, labour-intensive and expensive nature, and the extra precautions needed to address ethical concerns. While there is still much to be done to meet these challenges, the wide range of longitudinal research being conducted in the region is benefiting the understanding of health outcomes as an essential step in developing effective population and health policies, programmes and services in many countries of the region.

Endnote

1. An ethnic minority group originally from Myanmar currently living in areas of Thailand close to the Myanmar border.

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