Approaches in Methodology of a Population-Based Study in Malaysia: The National Health and Morbidity Survey 2011 (NHMS 2011)

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ABSTRACT
The National Health and Morbidity Survey 2011 was a nationally representative household survey of non-institutionalized Malaysian population who were residing in Malaysia for at least 2 weeks prior to data collection. The aim of the survey was to provide health related community–based data and information to support Ministry of Health, Malaysia, in reviewing health priorities, programme strategies and activities, and planning for allocation of resources. There were twelve research scopes included in the survey. The sample size was calculated based on the requirement for each scope. A two-stage stratified sampling was adopted in the survey. The methods for data collection were via the questionnaire, clinical examination, and biochemical analysis. Quality controls were also instituted to ensure collection of high quality data. The National Health and Morbidity Survey 2011 (NHMS 2011) adopted an appropriate methodology for a population survey and all the necessary steps were taken to ensure valid and reliable findings.

Keywords: National Health and Morbidity Survey, NHMS, population based survey, survey methodology, population study, Malaysia

INTRODUCTION
In 1986, the Ministry of Health, Malaysia, took the initiative of conducting the First National Health and Morbidity Survey (NHMS1) in Peninsular Malaysia, with the aim of providing supplementary data that could be used for the development and evaluation of health programmes in the country. The survey focused mainly on providing information on the load of illness and disability among population, as well as exploring health services utilization by the population. As a follow-up to NHMS1, the Second National Health and Morbidity Survey (NHMS2) was conducted in 1996. It adopted the scopes and approaches of NHMS1 so as to enable a comparison between the findings of NHMS1 and NHMS2. In addition, NHMS2 was also extended to Sabah and Sarawak to provide information of health status of the whole country. Ten years later, i.e. in 2006, the Third National Health and Morbidity Survey (NHMS3) was conducted. The survey retained as much as possible the important aspects of NHMS2 and also focused on other current health issues in the population[1-2].

From the first NHMS to the third NHMS, the survey was done in every ten years. With a ten-yearly survey, the information used was not very timely for planning of health programmes before the next NHMS could be conducted. Thus, the Ministry of Health felt that there is a need to conduct a more frequent population survey to ensure timely information for policy makers, particularly to support the implementation of 1Care for 1Malaysia, which is a health sector reform and transformation in Malaysia, and also the implementation of the 10th Malaysian Plan. The aim of the National Health and Morbidity Survey 2011 was to provide health related community–based data and information to support the Ministry of Health, Malaysia, in reviewing health priorities, programme strategies and activities, and planning for allocation of resources. This paper aimed to describe and the methodology used and its justifications in conducting the National Health and Morbidity Survey in 2011.

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MATERIALS AND METHODS

Scope of the Study
In identifying the scope of the survey, suggestions and feedback were obtained from Programme Managers in the Ministry of Health. The main research team members of NHMS 2011 reviewed and studied closely the suggested topics (before they were short-listed) based on the following criteria:

i. The issue/problem is currently or potentially of high prevalence;
ii. The issue/problem is associated with affluence, lifestyle, environment and demographic changes;
iii. The issue/problem causes significant physical, mental or social disability;
iv. The issue/problem has important economic implications;
v. The information required is not available through routine monitoring system;
vi. The information is more appropriately obtained through community survey;
vii. It is feasible to obtain the information through community survey.

The short-listed research topics were then presented to the National Health and Morbidity Survey Advisory Committee, Ministry of Health Malaysia, for further deliberation and decisions, particularly their inclusion in the survey. The study scopes were then tabled to the National Health and Morbidity Survey Steering Committee in the Ministry of Health Malaysia, which was chaired by the Director General of Health for the final approval.

Study Design and Specific Aims
The National Health and Morbidity Survey 2011 was a population-based, cross-sectional epidemiological study of the Malaysian population who were non-institutionalized and residing in Malaysia for at least 2 weeks prior to data collection. Individuals who were institutionalized such as people residing in hospitals, prisons, nursing homes, and other such institutions were excluded from the survey. The study was conducted by the Institute for Public Health, one of research institutes under the National Institute of Health, Ministry of Health Malaysia. Approval was obtained from the Medical Research and Ethic Committee, Ministry of Health Malaysia, prior to the study (NMRR No: 10-757-6837).

The main aims of NHMS 2011 were to determine the health care demand of the community in Malaysia; to determine the prevalence of non communicable diseases such as diabetes mellitus and hypertension; and the prevalence of risk factors of the non-communicable diseases such as hypercholesterolemia, physical inactivity, obesity, etc.

Sampling Frame and Sample Size
The sampling frame was provided by Department of Statistics (DOS), Malaysia. The sampling frame for this survey was updated in 2010 prior to the National Population and Housing Census 2010. Based on the frame, Malaysia was geographically divided into several enumeration blocks (EBs). An EB is a geographically continuous area with identified boundaries. There were about 75,000 EBs in Malaysia in the year 2010, with about 49,000 and 26,000 urban and rural EBs respectively. On average, each EB contained between 80 to 120 living quarters (LQs) with an average population of 500 to 600 people[3].

The EBs in the sampling frame was classified into either urban or rural EB. The classification was given by the Department of Statistics Malaysia based on the population size of the gazetted and built-up areas. The definition of an urban area is a gazetted area, with their adjoining built-up areas, which has a combined population of 10,000 or more at the time of census 2010[4]. Meanwhile, a gazetted area with a combined population of less than 10,000 is classified as rural area[4].

The sample size was calculated using an appropriate formula for a study estimating population prevalence, and it was determined based on the expected prevalence of diseases or health related problems in the population, margin of error and confidence interval[5-7]. The sample size was determined on the basis of the ability to estimate the prevalence of the health conditions specified in this study, with adequate or acceptable precision. In calculating the sample size, the primary outcome measures for each scope were determined by the respective research group, and the estimated prevalence of each outcome measure was used in the calculation. Previously published data were used to estimate the prevalence of these conditions[1-2]. Depending on the prevalence of the diseases or health related conditions, the precision for the individual objective was determined accordingly[8].

The sample size was then inflated to consider for the estimated design effect and non-response. Information on the design effect was based on the Third National Health and Morbidity Survey 2006[1-2]. The sample size was
then adjusted according to the need of the analysis, i.e. whether the estimate was going to be done at the national, urban and rural levels or at the state, urban and rural levels.

There were several scopes included in this study, with different target populations and intended level of estimation to be made. Table 1 shows the scope of the study with the corresponding target population and at what level the analysis was intended to be done.

<table>
<thead>
<tr>
<th>Scope</th>
<th>Target population</th>
<th>Level of analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care demand</td>
<td>All age group</td>
<td>State (urban and rural)</td>
</tr>
<tr>
<td>Nutritional status</td>
<td>18 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Nutritional status</td>
<td>Children (&lt;18)</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>18 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>18 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>18 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Alcohol</td>
<td>13 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Physical activity</td>
<td>16 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Home Injury</td>
<td>60 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Home Injury</td>
<td>&lt; 7 years</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Mental health</td>
<td>16 years and above</td>
<td>National (urban and rural)</td>
</tr>
<tr>
<td>Mental health</td>
<td>5 - &lt;16 years</td>
<td>National (urban and rural)</td>
</tr>
</tbody>
</table>

Table 2 shows the minimum sample size by the scope of the study with different levels of precision before adjusting for the non-response. The sample size was then inflated 20 percent to cover for the non-responses. This increment of 20 percent was decided based on the experience from the previous National Health and Morbidity Survey[1-3].

<table>
<thead>
<tr>
<th>Scope</th>
<th>Prevalence</th>
<th>Precision (95% CI)</th>
<th>Minimum sample size per strata</th>
<th>Number of strata</th>
<th>Total required sample size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care demand</td>
<td>23.6</td>
<td>18.6-28.6</td>
<td>680</td>
<td>28</td>
<td>19050</td>
</tr>
<tr>
<td>Nutritional status (Adult)</td>
<td>8.5</td>
<td>6.0-11.0</td>
<td>641</td>
<td>2</td>
<td>1282</td>
</tr>
<tr>
<td>Nutritional status (Children)</td>
<td>5.4</td>
<td>3.4-7.4</td>
<td>672</td>
<td>2</td>
<td>1344</td>
</tr>
<tr>
<td>Diabetes Mellitus</td>
<td>11.6</td>
<td>9.1-14.1</td>
<td>900</td>
<td>2</td>
<td>1800</td>
</tr>
<tr>
<td>Hypertension</td>
<td>37.7</td>
<td>32.4-42.2</td>
<td>578</td>
<td>2</td>
<td>1156</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>23.0</td>
<td>18.0-28.0</td>
<td>504</td>
<td>2</td>
<td>1008</td>
</tr>
<tr>
<td>Alcohol</td>
<td>7.4</td>
<td>5.4-9.4</td>
<td>1217</td>
<td>2</td>
<td>2434</td>
</tr>
<tr>
<td>Physical activity</td>
<td>27.4</td>
<td>22.4-32.4</td>
<td>892</td>
<td>2</td>
<td>1784</td>
</tr>
<tr>
<td>Home Injury (Adult)</td>
<td>5.0</td>
<td>3.0-7.0</td>
<td>912</td>
<td>2</td>
<td>1824</td>
</tr>
<tr>
<td>Home Injury (Children)</td>
<td>5.0</td>
<td>3.0-7.0</td>
<td>912</td>
<td>2</td>
<td>1824</td>
</tr>
<tr>
<td>Mental health (Adult)</td>
<td>11.6</td>
<td>8.6-14.6</td>
<td>875</td>
<td>2</td>
<td>1750</td>
</tr>
<tr>
<td>Mental health (Children)</td>
<td>20.3</td>
<td>15.3-25.3</td>
<td>497</td>
<td>2</td>
<td>994</td>
</tr>
<tr>
<td>Mental health (Children)</td>
<td>20.3</td>
<td>14.3-24.3</td>
<td>777</td>
<td>2</td>
<td>1554</td>
</tr>
</tbody>
</table>
The number of sample allocated for each state, urban and rural was done proportionally to the population size. A bigger number of samples were allocated to the states with a bigger population size such as Selangor, Johor and Sabah, whereas a less number of samples were allocated to the states with smaller population size such as Perlis, Melaka and Putrajaya. The sample size for each stratum was reviewed and the sample size in some strata at the state level had been inflated to ensure the number met the minimum requirement for the analysis.

**Sampling Design**

The sampling for this study was done with the assistance from the Department of Statistics, Malaysia. In order to ensure national representativeness, the two-stage stratified sampling was adopted in the survey. The strata were the primary stratum, which was made up of the states of Malaysia, including Federal Territories, and the secondary stratum, which was made up of the urban and rural stratum formed within the primary stratum.

The sampling involved two stages; the primary sampling unit (PSU) was the enumeration block (EBs) and the secondary sampling unit (SSU) was living quarters (LQs) within each selected EB. The first stage of the sampling involved a random selection of EBs. A total of 794 EBs were selected, with 484 and 310 EBs selected from the urban and rural areas, respectively. The second stage of the sampling involved a random selection of LQs from the selected EBs. Twelve LQs were randomly selected from each selected EB. All households within the selected LQs and all eligible respondents in the households were included in the study.

**Preparation of the Field Areas and Logistic Support**

Several categories of supports were recruited from every state. In each state, a liaison officer was identified to assist the central team in the logistic preparation of the survey. These liaison officers assisted in the delivery of information regarding survey and liaised with the selected communities, relevant district health office and Local Authorities for logistic arrangement, such as transportation and accommodation.

Scouts were identified from the staff of the District Health Office in the selected districts. The scouts had identified and tagged the selected LQs based on the EB maps provided by the Department of Statistics before the actual data collection. They had also informed members of the selected LQs, community and related government agencies information related to the survey, including the scheduled plan for data collection.

**Study Instruments and Data Collection Techniques**

Data collection was done using questionnaire (either face-to-face interview or self-administered, depending on the module), clinical examination, and biochemical analysis.

Meanwhile, structured questionnaires were used to collect data on the scopes of the survey. There were two types of questionnaire developed: face-to-face interview and self-administered questionnaires. For the face-to-face interview, a bi-lingual (Malay and English) questionnaire was designed, pre-tested and validated. The self-administered questionnaires were prepared in four languages, namely, Malay, English, Mandarin and Tamil, and also pre-tested and validated prior to the survey.

There were several modules included in the questionnaire. The household questionnaire contains household particulars, household roster and some basic questions on the household. The individual questionnaire (face-to-face interview for the respondents aged 13 years and above) contains module on socio-demography, load of illness, health service utilization, dental or oral health care, out-patient care, health care costs for appliance, promotion and preventive care, health problems, general health, personal risk factors, dietary practices, physical activity, diabetes mellitus, hypercholesterolaemia, hypertension, home injury, mental health and a module on selected clinical assessment. The individual questionnaire (face-to-face interview for respondents aged less than 13 years) contains modules on socio-demography, load of illness, health service utilization, dental or oral health care, out-patient care, health care costs for appliance, promotion and preventive care, health problems, general health, personal risk factors, home injury, mental health and clinical assessment on nutritional status of the children. There were two modules included in the self-administered questionnaire; the alcohol module for respondents aged 13 years and above, and the psychiatric morbidity module for children 5 to 15 years of age.

All members aged 13 years and above in the household were interviewed face-to-face by data collection teams. For those who were 12 years and below, their proxy (parents or guardian) were interviewed. Similar rules were also applied to the self-administered questionnaire. The respondent’s height was measured in centimetre using Seca 206 Bodymeter for those above 2 years old\(^{(9)}\) or Seca 210 Measuring Mat for the respondents below 2 years old\(^{(10)}\). Weight was measured in kilograms using a digital weighing machine (TANITA HD-319) for the respondents above 2 years old\(^{(9)}\) or 1583 Professional Scale for the respondents below 2 years old\(^{(11)}\). Blood pressure was taken with the participants seated and after 15 minutes of rest. Blood pressure was measured by using a digital...
automatic blood pressure monitor (OMRON)\(^{[12]}\). Two readings of the systolic and diastolic pressures were taken at
15 minutes apart. Blood glucose level was examined for non-diabetic adult respondents after an overnight fasting
using finger prick method and blood cholesterol levels were examined for all adults. Both examinations were done
using Cardiocheck machine\(^{[13]}\).

In data collection, arrangement for the visits was made by the team leader before the actual visit. The team
had also made several attempts to ensure completeness of the questionnaire and a coverage of all members in the
household. At least three visits at different times were attempted before the households were classified as non-
respondents.

An information sheet and a consent form were made available for every respondent. For minor or disabled,
a sign consent was taken from the guardian with a witness. For an illiterate respondent, a thumb print was also
taken from the respondent with a literate person as a witness.

**QUALITY CONTROL**

Quality control of the whole survey was done at various stages. During the planning stage, quality was ensured
through correct survey design, proper development of questionnaires, using validated tools, and standardized
manuals and training. On the field, quality control was done to ensure that data collected were of high-quality.
The field supervisors randomly observed the interviews done by the interviewers and also the clinical and blood
investigations done by the nurses. The team leaders would also check the completeness of the questionnaires and
the validity of the answers given by the interviewers and nurses. At the central level, the entire questionnaires
received from the field were checked for the validity of the answers, including the skip pattern before the data
were entered into the database.

**Data Entry and Analysis**

Data entry system was developed to record the information collected. It is a web-based system that allows multiple
simultaneous accesses to the database. NHMS 2011 used a double data entry method and any discrepancy between
both entries was verified by a supervisor.

Data analysis was done by exporting the raw data [in Comma-separated values (CSV) form] into other statistical
tools such as SPSS and STATA. The data were then checked and cleaned. The distributions and categories were
examined. Categories with small sample sizes and skewed distribution were noted. Meaningful combination of
categories was done when it was indicated. Analysis was done according to the working definition and dummy
tables prepared by each research group.

The sample weight was calculated, starting with the calculation of the base or design weight, and the weight
was then adjusted for the non-responses. In general, the weight of a sampled unit is the reciprocal of its probability
of selection into the sample. The final weight used in the analysis was the post-stratification weight based on the
information from the 2010 census in Malaysia\(^{[4]}\). Taking into consideration the sampling design, which was a
complex sampling design, the analysis was done accordingly\(^{[14]}\). Prevalence estimates for all the outcomes were
also performed. All the analysis processes were done by a data management team.

**RESULTS**

The estimated population from this survey was compared to the estimated population based on the 2010 Census.
The sample was a representative of Malaysia’s population of 2010, as shown in Figures 1 and 2. Population pyramid
was almost identical with only a slight difference at every age-group and by sex. Details of socio-demographic
profile are explained in Table 3.

**DISCUSSION**

The National Health and Morbidity Survey 2011 (NHMS 2011), which is a nationwide cross-sectional survey in
Malaysia, was carried out with the aim to provide population-based data on the prevalence of selected diseases and
health related problems in the country. The study was properly planned and designed in term of its methodology
to ensure valid and reliable findings. It was done to support the Ministry of Health, Malaysia, in reviewing health
priorities, programme strategies and activities, and planning for allocation of resources. The aim of this paper is
to describe the methodology used and its justifications in conducting the study.

NHMS allows a comparison of the estimates between the urban and rural areas at the national level for all the
scopes included in the study. As for health care demand component, the requirement for analysis was at the state,
urban and rural levels. As such, the sample size calculation and sampling process had been carried out accordingly to fulfill the requirement of the analysis.

In calculating the sample size for this study, the highest margin of error was set at 5%. Naing et al. (2006) stated that it is appropriate to have a precision of 5% if the prevalence of the disease is between 10% and 90%. However, when the prevalence is below 10% or more than 90%, the precision of 5% is no longer appropriate and it needs to be adjusted accordingly. Thus, besides looking at the precision, relative standard error should also be examined to make sure that it did not exceed 25%. It has been stated that generally, if the relative standard error is 25% or less, results have reasonable accuracy[15].

The design effect for each scope in this study was estimated based on the previous NHMS[1-2]. Design effect is the ratio of the variance of an estimate based on the complex survey design relative to the corresponding variance of the same sample size, if a simple random sampling is used[16-17]. Design effects in a survey data are caused by three features of the sample design and estimation process: stratification of the survey population prior to selection; clustering or grouping of elements in the process of sample selection; and differential weighting of sample units in estimation and analysis[17]. For a well designed study, the design effects generally range from 1 to 3[18]. Meanwhile, the maximum design effect used in the sample size calculation for NHMS 2011 was 3, which was for the healthcare demand module.
For NHMS 2011, as with most population studies, a comprehensive list of all survey-eligible individuals in the country did not exist, thus, making sampling from a list of frame impossible. Consequently, an indirect cluster sampling frame was used to select the sample. In this study, a two stage stratified sampling was used in the sampling process and it was considered as the most appropriate and practical sampling method for this survey. Stratification by states and urban/rural localities would increase the national representativeness of the sample. The same sampling method was also used in the previous NHMS[19]. Hsia et al. (2010), in their population-based survey on tobacco use in China, also used a similar sampling method[20].
A few factors have been considered in deciding the sampling process. An adequate number of LQs must be sampled from each stratum in order to get the required number of respondents. Based on the information from the previous NHMS on the average number of respondents per LQ, the number of LQ sample was determined. The number of LQs randomly selected from each EB was determined after considering the statistical implications and the practical issues in conducting the survey. This was done to ensure that the number of LQs selected for each EB not too big to cause high clustering effect or design effect, and at the same time, it was not too small to cause more EBs to be sampled as this would give negative implications on the resources. It has been shown that when the sample is constant, observed design effects and standard errors decrease with the increase in the number of cluster and thus reduces the mean cluster size\(^{(2)}\). In NHMS 2011, 12 LQs were randomly selected from each selected EB.

In conducting a nationwide population survey like NHMS 2011, a good collaboration and support from relevant agencies and department is very crucial. The sampling frame and sampling process for this survey were provided by the Department of Statistics (DOS), Malaysia. Enumeration block (EB) maps for data collection activities and information on Malaysian population from 2010 census for calculation of post-stratification weight of the sample were also provided by DOS, Malaysia. A strong support on the sampling by the Department of Statistics, Malaysia helped to reduce sampling errors in the survey. Besides the Department of Statistics, good cooperation and support were also given by the state and district health offices, especially during the field works.

In conducting NHMS 2011, only some selected scopes were included in the survey. Diseases or any health problems with low prevalence could not be covered since a very big sample size would be required. Similarly, only some conditions could be estimated at the state level such as healthcare demand, hypertension and diabetes mellitus. The analysis of some modules that require a bigger sample size for each strata was only intended at the national, urban and rural levels. Another limitation is on the sampling design. Although NHMS 2011 was designed to sample Malaysian population all over the country, some very remote areas in Sabah and Sarawak were still excluded from the sampling frame. This was mainly due to logistic reasons, where the only access to some of the areas is by boat or air transport. In spite of these limitations, the design of NHMS 2011 is generally effective.

In summary, NHMS 2011 has adopted an appropriate methodology for a population survey. All the necessary steps had been taken, starting from planning of the survey, determination of the sample size, sampling design, development and validation of the questionnaires, data collection techniques, quality assurance measures, and data processing (including data entry, data cleaning and analysis) to ensure retrieval of valid and quality data.

REFERENCES


