



REVIEW ARTICLE

Hypertension surveys in the developing world. Lessons from the Egyptian National Hypertension Project (NHP)

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Accurate national estimates of the prevalence of hypertension in developing countries are lacking. Inadequate funds, inexperience and lack of infrastructure are also important barriers to hypertension research. The aim of this review is to help investigators from the developing countries, with limited resources, to design and conduct national hypertension surveys. The information is mostly based on the experience gained during the Egyptian National Hypertension Project (NHP) which can

serve as a model for similar surveys elsewhere. The review addresses a number of important questions: (1) Why conduct a national hypertension survey in a developing country; (2) What kind of data are needed; (3) Where to start and how to raise funds; (4) Who will carry out the survey; (5) How to design your sample and where to survey; (6) How to organize and perform field operations; (7) How to collect accurate data and do quality control measures; and (8) How to handle the data?

Keywords: hypertension; developing countries; Egypt

For many years, public health planning in most developing countries has focused mainly on the diagnosis, prevention and control of communicable diseases which were responsible for most morbidity and mortality. In recent decades the health profile has changed dramatically in many parts of the developing world. Infectious, nutritional and parasitic diseases are now better controlled and there has been a sharp decline in infant mortality rate. Both factors have led to an increase in average life expectancy. In Egypt it increased from 51.6 to 62.8 years for men and from 53.8 to 66.4 years in women.¹ Furthermore, the lifestyle of a major proportion of the population in these areas has undergone important changes,²⁻⁴ with the introduction of industrialization, increased urbanization and internal immigration to cities, changes in dietary habits (excess salt and calories), obesity, less physical activity and increased psychosocial stresses. These factors have changed the epidemiological profile from that of a developing country to a profile resembling a western industrialized nation.⁵ Increased longevity and the hazards of a western lifestyle have increased the incidence of diseases of middle and old age, namely degenerative and cardiovascular diseases. Cardiovascular diseases are now the main cause of death in Egyptians. In 1970, cardiovascular diseases accounted for 12.4% of all deaths, whereas two dec-

ades later, they were responsible for 42.5% of the nation's mortality.¹

Information regarding national estimates of the prevalence of hypertension and other cardiovascular diseases is lacking in developing countries. Except for limited surveys in localized geographical areas or in special groups (Table 1),⁹⁻²¹ there are no estimates of the magnitude of hypertension and its consequences in the developing world. Furthermore, the majority of hypertension surveys conducted in these countries are limited by sampling bias, measurement errors and lack of quality control measures. The sample of subjects studied may not be a random sample of the population. On many occasions, the people studied are those that agreed to be included or who happened to be around on the day when the research team was there.⁶ It is generally incorrect to assume that such reported values represent the population at large. In addition to sampling biases, studies from third world countries are limited by inaccurate measurements and limited numbers of blood pressure (BP) readings (one or two per subject), lack of standardization, and by observer biases such as digit preference.^{7,8}

National hypertension surveys are necessary in order to define the magnitude of the hypertension problem in the population. Such information helps alert health authorities and public health planners to direct resources and to take treatment and preventive measures against hypertension if this turns out to be a large problem. The data collected should encourage the establishment of national hypertension societies and the initiation of national campaigns in order to increase public awareness of hypertension. This should encourage regular check-

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Table 1 Hypertension prevalence data in some developing countries

Country & location	Sample size	Age range	Survey year	HTN Definition mm Hg	Prevalence (%)					Ref. No.
					Total	Male	Female	Urban	Rural	
Bangladesh – Villages	5026	10–	82	DBP ≥90	6.07					9
Ethiopia – Villages	478	15–	83	BP ≥160/95	1.08	2.0	1.3			10
Brazil – Sao Paolo City	5470	15–	78	DBP ≥90		18.1	6.5			11
Egypt – Rural	5747	15–	58	SBP ≥160 and/or DBP ≥95	3.86					12
India – Delhi City	13 723	25–64		≥160/90	12.08	11.7	13.7			13
India – Urban	4068	20–65	82	≥160/95				6.4	3.6	14
Costa Rica – Urban & Rural	465	20–65	88	DBP ≥90				16.0	13.0	5
Tanzania – Rural	608	20–64		BP ≥160/95	2.0					15
Zaire – Urban	675	≥20	83/84	BP ≥160/95	9.09	13.6	6.8			16
Tibet – Rural	35 629	15–	79	BP ≥160/95	9.94	9.32	10.8			17
China – Urban & Rural	4 012 128	15–	79/80	BP ≥140/90	7.73	6.96	8.43	10.8	6.2	18
Nigeria – Benin City	1263	25–74	77	≥160/100		14	10			19
Jaipur-Urban	2122	20–	94	≥140/90 ≥160/95		30 11	33 12			20
Caribbean – Barbados, Jamaica, St Lucia – Urban	2704	25–74	95	≥140/90 ≥160/95		26.6 19.1	23.3 15.0	29.1 22.2		21

ing of BP, modifications of lifestyle and dietary habits and recommendations directed at the food industry. These preventive measures should help reduce the incidence of the disease.²² Organization of patient and physician education programmes may improve hypertension control and prevent its complications.

In addition, the scientific community will benefit from the information collected in such surveys. Research evidence links increased risk for essential hypertension to a number of environmental, behavioural and demographic characteristics in the population, i.e. the hypertension risk factors.^{23–39} The possible variations in prevalence figures between different populations (inter-population) and between different regions in the same population (intra-population) might help answer questions related to the role of genetic and environmental factors in the development of hypertension. Some of the unanswered questions include the role of salt sensitivity, psychosocial stress, skin colour, dietary habits, noise and lead pollution and parasitic (schistosomal) infections. Table 2 shows examples of areas that need further epidemiological research.

The Egyptian National Hypertension Project (NHP)

The Egyptian NHP is the first national hypertension survey in an Arab country.^{40–42} It provides a large database not only concerning the prevalence of hypertension (Figures 1 and 2), and hypertensive complications among Egyptians but also about hypertensive and cardiovascular risk factors. As such, the Egyptian NHP can serve as a model for similar surveys in the developing world. NHP was

Table 2 Recommended research areas in epidemiology of hypertension

1. Hypertension prevalence:
 - (a) National Surveys
 - Interpopulation comparisons.
 - Differences in distribution of BP and rate of progression with age.
 - (b) Intrapopulation Studies
 - Different geographic areas, ethnic groups, demographic and environmental variations.
 - (c) Migration Studies
 - Cross-sectional
 - Cohort (longitudinal): Prospective and retrospective
2. Hypertension risk factors:
 - (a) In specific populations: Determinants of differences between populations.
 - (b) In special groups: eg, lean vs obese.
 - (c) Subpopulations particularly susceptible.
 - (d) Identify high risk individuals.
 - (e) Mechanisms relating obesity, insulin and diabetes to hypertension.

planned and executed by Egyptian scientists in collaboration with experts from the USA.

Funding and support from the USA underscored the value of international cooperation in public health research programmes. Most of the Egyptian investigators of NHP were clinicians who had a limited background in cardiovascular epidemiology, who acquired a lot of experience during the 3 years of the survey. This experience covers a wide range of information in design and execution of national surveys in developing countries.⁴¹ NHP consisted of a number of stages. A preparatory stage of 10 months preceded the actual field operations. The field survey was carried out during the period of December

Table 3 Scope of hypertension surveys in developing countries

Category	Funds	Data collected	Research instruments
A	Limited	<ul style="list-style-type: none"> ● BP distribution ● Hypertension prevalence 	Brief QFs Sphygmomanometers
B	Moderate	<ul style="list-style-type: none"> ● BP distribution ● Hypertension prevalence ● Hypertension awareness, treatment & control ● Some hypertension risk factors 	Detailed QFs Sphygmomanometers, scales for weight & height, simple biochemical lab
C	Large	<ul style="list-style-type: none"> ● B + detailed hypertension risk factors ● Hypertension complications ● Other CV risk factors ● Special studies: ABP, ASO changes, skin colour, drinking water, noise pollution, etc. 	B + Ophthalmoscope, ECG, Echo, elaborate biochemical lab, spectrophotometer, cardiac duplex ultrasound, ABP recorder, etc.

QFs: questionnaire forms; ABP: ambulatory blood pressure; ASO: atherosclerotic; BP: blood pressure; ECG: echocardiogram.

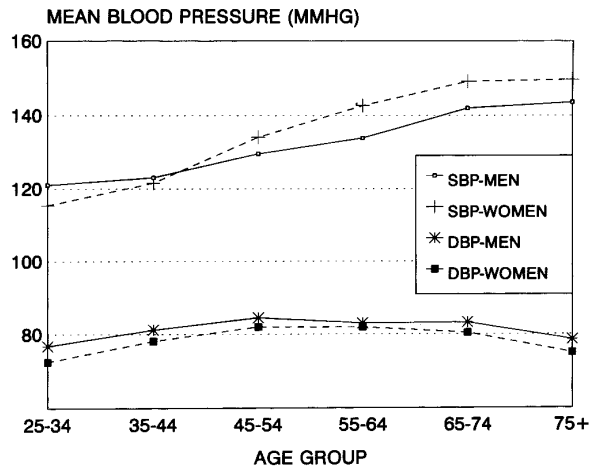


Figure 2 Line graph shows estimated mean systolic (SBP) and diastolic (DBP) blood pressure by age and sex among Egyptian adults (1991 to 1993). (From Ibrahim *et al.* Hypertension prevalence, awareness, treatment and control in Egypt; results from the Egyptian National Hypertension Project (NHP). *Hypertension* 1995; **26**: 886–890. Reproduced with permission from the publisher).

1991 to May 1993. Data entry was completed at the beginning of 1994. Field operations were carried out in 21 sampling locations in six Egyptian governorates representing all Egyptian geographical areas and socio-economic groups. The sample size was 7915 individuals. The field survey consisted of two phases. The objectives of phase I were to identify hypertensive individuals and to collect data about the social, demographic and environmental characteristics of the sample. During phase II of the survey, complete clinical evaluation including ECG, echocardiogram and optic fundus examination was performed together with collection of blood and urine samples from hypertensive individuals and age- and gender-matched normotensives. Additional sub-studies were conducted in a subset of the sample. Measuring skin colour reflectance and studying its relationship to BP in a large population was a special feature of NHP. The project was one of the first surveys to conduct a large scale echocardiographic field study in a developing country.

Finally, the four BP measurements, the sample design and the rigorous quality control procedures, encourage confidence in the validity of the information and data collected.

Data collected in hypertension surveys

The first issue which should be addressed by the investigators at the outset of any national survey is identification of the type and extent of information they plan to collect. The answer depends upon a number of factors, the most important of which is the amount of available funds.

The scope and extent of a hypertension survey can belong to one of three categories, namely A, B and C, based upon the funds available and the amount of data collected (Table 3).

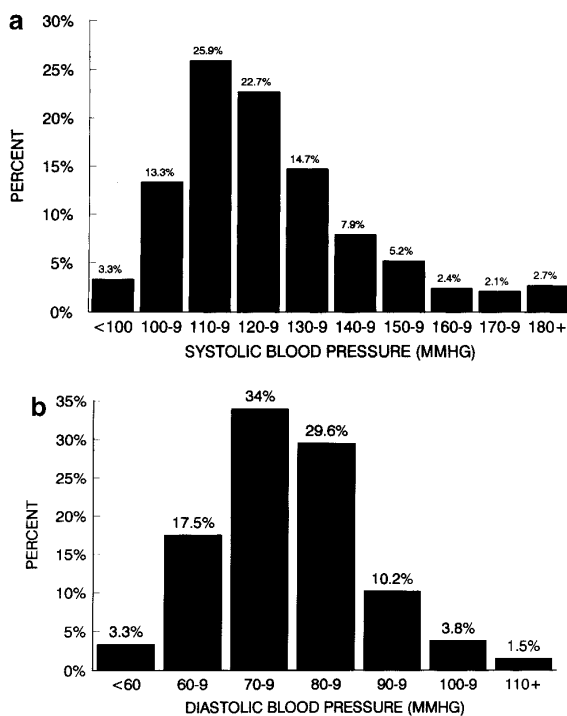


Figure 1 Bar graphs show distribution of systolic (a) and diastolic (b) blood pressures in Egyptian men and women; weighted estimates from the National Hypertension Project (1991 to 1993). (From Ibrahim *et al.* Hypertension prevalence, awareness, treatment and control in Egypt; results from the Egyptian National Hypertension Project (NHP). *Hypertension* 1995; **26**: 886–890. Reproduced with permission from the publisher).

Category A

This is a small, limited survey collecting the minimal amount of data and requiring the least amount of funding. Sample size may be small and not representative of the entire target population. Field operations include filling a limited questionnaire and BP measurements. Data collected will provide hypertension prevalence in the sample according to age, gender, ethnicity and urban and rural distribution. National estimates are usually derived from larger samples with a more complex design, in order to represent all the nation's geographic areas, ethnic and socio-economic groups.

With limited funds and in the absence of a national census, investigators can carry a regional survey in one or two geographical areas that may represent most of the demographic and environmental characteristics of the nation. However, the data will not provide a true national prevalence estimate.

Category B

This survey, which necessitates reasonable funding, requires use of more elaborate and time consuming questionnaires and additional measurements. The data will further address the rate of hypertension awareness, treatment and control, and the prevalence of some hypertension risk factors in the population (Table 4). Identification of these hypertension risk factors will help answer the question why an individual, group of individuals, a community or an entire nation is at increased risk of high BP. The recognition and possible modification of these risk factors may eventually reduce the incidence of hypertension and its cardiovascular complications.²²

The cost and duration of the survey are increased by collecting information about body weight, waist/hip ratio, socio-economic status, occupational and social stress, level of education and sodium intake. Investigators should make a list of variables that may be associated with or are predictors of hypertension (Table 4). Even though the identification of hypertension risk factors is possible, it is

Table 4 Hypertension risk factors

1. Positive family history.
2. Obesity and androgenic body fat distribution.
3. Psychosocial stress:
 - (a) Social isolation
 - (b) Poor education and low socio-economic status
 - (c) Unemployment
 - (d) Job stress
 - (e) Marital stress
4. Dietary factors:
 - (a) Salt excess
 - (b) Deficient potassium
 - (c) Deficient calcium, magnesium and macronutrients
5. Alcohol excess.
6. Dark or black skin colour (?).
7. Impaired glucose tolerance and hyperinsulinism.
8. Environmental pollution: noise, lead.
9. Drugs: oral contraceptives.
10. Parasite infestation: schistosomiasis.
11. Personality type.
12. Sedentary lifestyle.

however, difficult to establish in a cross-sectional study a causal relationship between the outcome, ie, hypertension, and predictors, ie, risk factors. Cohort (longitudinal) studies or experiments are usually needed to prove this relationship. The closeness of the relationship between high BP and environmental, demographic and behavioural risk factors are governed by many confounding variables, the most important of which is possibly the genetic background or genetic predisposition to the risk factor in question.

Category C

This is a large survey that requires large amounts of funds, but will collect in addition to previous data, more information about hypertension risk factors, prevalence of hypertensive complications (Table 5) and other cardiovascular risk factors, for example, diabetes mellitus, cigarette smoking, dyslipidaemia. There is possibly a racial or genetic predisposition to some hypertensive cardiovascular and renal complications.^{43,44} Left ventricular hypertrophy, heart failure and renal failure have been reported to be more common in the black race.^{45,46} The reasons for these differences are not understood and the cause of racial variations in responsiveness to antihypertensive drug therapy⁴⁷ is not clear. These racial differences in hypertensive complications were not studied in the developing world.

A study of the prevalence of hypertensive complications in a national survey requires the conduct of expensive studies such as ECG, echocardiography, fundoscopy, ultrasound duplex scanning, Holter ECG and biochemical studies on a large sample of the population.

The cost of the survey will be increased, the more data the investigators wish to collect. The length of questionnaire and data collection time will be increased, more equipment has to be purchased and its transportation to distant field areas will complicate the logistics of the study, while more trained and experienced personnel will be required. How-

Table 5 Hypertensive cardiovascular complications

- (A) Subclinical:
 1. Coronary artery disease:
 - (a) Silent myocardial ischaemia.
 - (b) Silent myocardial infarction.
 2. Increased left ventricular mass.
 3. Impaired left ventricular diastolic function.
 4. Impaired left ventricular systolic function.
 5. Arrhythmia.
 6. Carotid and peripheral atherosclerosis.
 7. Aortic aneurysms.
 8. Optic fundus changes.
- (B) Clinical:
 1. Coronary artery disease:
 - (a) Angina pectoris.
 - (b) Myocardial infarction.
 2. Heart failure.
 3. Stroke.
 4. Transient ischaemic attacks.
 5. Claudication.
 6. Aortic dissection.

ever, it is acceptable to conduct some of the sophisticated or elaborate studies on a subset or limited number of individuals in the sample frame.

Costs of a national survey

The costs of a national hypertension survey in a developing country should be less than those in the western world, as everything is less expensive such as wages, consultancy fees, travel and accommodation, expenses of training and services, and it is feasible to conduct a very extensive field survey (category C) for less than it would cost in comparison to a similar study in a western country. The Egyptian NHP, a category C survey with a large sample size (7915 individuals) and 64 working staff over a 3-year period, had a budget of approximately 1 million US Dollars during the years 1991–1993. Table 6 shows the NHP budget itemized over 3 years.

Where to start? The research proposal and fund raising

Research proposal

Before searching for sources of funds, the investigators should write a research proposal that contains the study protocol and other administrative or supportive information. In developing countries some funding sources provide written guidelines that the investigators must study before writing the proposal. The investigators should organize the proposal according to the recommendations of the agency that will receive it. In general, a good proposal should contain the following elements and be organized as follows:

- (1) title;
- (2) project duration;
- (3) proposed date for start of activities;
- (4) executive summary;
- (5) layman statement of the problem;
- (6) background and significance of the project;
- (7) primary and secondary objectives;
- (8) methods, which should include: overview of design, type of data collected, research instruments, study subjects, sampling method and plan of recruitment, measurements;

- (9) pilot studies;
- (10) quality control;
- (11) data management;
- (12) time table;
- (13) available resources, eg, space, personnel, equipment, facilities;
- (14) budget, which includes budget itemization and budget justification;
- (15) short CV of the investigators;
- (16) references;
- (17) appendices.

Budget

The majority of funding institutions provide guidelines and a format for a detailed budget. Budget allocation includes the following expenses:

- (1) personnel (salaries, incentives, fringe benefits);
- (2) consultant costs;
- (3) travel (transportation, accommodation, *per diem*);
- (4) preparation and printing of questionnaire forms and other printed material;
- (5) equipment (including a van for field work and laboratory equipment);
- (6) remodelling and site preparation;
- (7) supplies;
- (8) computer work, other services and subcontracts, eg, translation, statistical analysis, advertisements;
- (9) training and educational material (books, slides, video films);
- (10) telephone, mail, fax and copying facilities.

Sources of funding

In developing countries, the following are the potential sources of funding:

- (1) government organizations, eg, Ministry of Public Health, Ministry of Scientific Research, Medical Research Council;
- (2) scientific societies, eg, National Hypertension Society, Medical Association;
- (3) private organizations, eg, Rotary Club;
- (4) International and foreign agencies, eg, WHO, US-AID;
- (5) pharmaceutical industry;

Table 6 Egyptian National Hypertension Project Budget (1991–1994)

Line item	Year 1		Year 2		Year 3		Total	
	\$ US	LE	\$ US	LE	\$ US	LE	\$ US	LE
Consultancy	0	158 200	0	114 867	0	120 000	0	393 067
International travel	13 000	14 667	10 400	17 600	46 070	17 600	69 470	49 867
Local travel	0	48 950	0	48 000	10 400	0	10 400	96 950
Training	0	38 000	0	0	32 760	0	32 760	38 000
Equipment	341 558	0	41 600	25 200	80 080	13 198	463 238	38 398
Furniture/supplies	8000	92 224	0	0	26 210	0	34 210	92 224
Services	0	72 000	0	42 000	0	106 946	0	220 946
Other expenses	0	0	0	0	10 400	0	10 400	0
Total	362 558	424 041	52 000	247 667	205 920	257 744	620 478	929 452

\$ US: United States Dollars; LE: Egyptian Pounds; (US \$ ≈ 3.35 LE).

- (6) private donations from individuals, banks, non-governmental organizations.

The principal investigator should approach both in person and in writing quoting the sources of funding in his country and submit a copy of his research proposal with a covering letter including a short summary of the project.

More than one organization can share in funding the survey. Each of the previous sources of funds has its limitations, difficulties and internal policy. The WHO funds limited surveys if approved by the regional office. Funds from US-AID are generally part of a cooperative health programme. This source can fund large surveys, eg, NHP. However, even if funds are available, mutual approval of both governments is mandatory. A fund-raising campaign can be conducted under the sponsorship of a national scientific society. Rotary clubs can support small and limited surveys. Government agencies can fund large projects if investigators are familiar with the agency and can provide convincing evidence of the importance of the study at a national level. The survey will take priority if it is useful for government health planning. The scientific calibre of the principal investigator, his background and expertise may help in approval of funding if money is available.

The investigators have to compete with other priorities that require funding in a developing country, for example, housing, transportation, clean water, employment, education, hospital care, etc.

Design of a national hypertension survey: preparatory stage (Table 7)

Recruitment of personnel

The first step after approval of funding is the recruitment of project staff by the principal investigator (PI). The number, type and qualification of staff will depend upon the extent and scope of the survey.

Table 7 Design of a national hypertension survey

Preparatory stage:
<ul style="list-style-type: none"> ● Recruitment of personnel ● Site preparation and purchase of equipment ● Construction of questionnaire forms and other printed material ● Training and certification of research team ● Sample design and choice of survey areas ● Pilot studies ● Quality control measures ● Other administrative activities
Field operations:
<ul style="list-style-type: none"> ● Time frame ● Preparatory visits ● Survey team ● Content of home visit ● Establishment of local health centre ● Quality control ● Special studies (substudies)
Data handling:
<ul style="list-style-type: none"> ● Data entry ● Quality control ● Statistical analysis

The following are the different groups of personnel that were involved in NHP activities.

(1) *Senior or central office physicians (COPs)*: This group, mostly physicians, helped the PI in the planning and execution of the field survey; training and certifying data collection staff (interviewers), supervising field operations, conducting quality control procedures, and performing clinical and laboratory evaluation. COPs worked through a number of more specialized subcommittees responsible for well defined activities. These were:

- (1) field operations;
- (2) equipment;
- (3) site preparation;
- (4) budget;
- (5) public relations;
- (6) library and information;
- (7) training;
- (8) computer and data entry;
- (9) biochemical lab;
- (10) ECG;
- (11) echocardiography;
- (12) special studies;
- (13) quality control;
- (14) writing and publication;
- (15) future planning.

All COPs had post-doctoral training in cardiology or laboratory techniques. They met regularly (weekly) with the PI, carried out subcommittee activities and travelled with interviewers during field operations. All were part-timers and conducted NHP activities beside their routine hospital and clinical commitments.

(2) *Data collection staff (interviewers)*: These made the home visits, filled the questionnaire forms, measured BP and heart rate, did anthropometric measurements, and assisted in ECG and echocardiographic studies. Some had special training and helped in computer work and data entry. Interviewers can be medical students, technicians, nurses or newly graduated doctors. These different options were discussed and probed by NHP investigators and it was decided that young doctors were the best choice. Before joining the project, the scope and objectives of NHP were explained and they were told they should be willing to travel to rural areas and to spend 3 years in the NHP. After a provisional interview, they received training courses (see later) and were certified if they passed a written and practical examination. It was also decided to have one central team of interviewers instead of recruiting local physicians in sampling locations. This helped to ensure an excellent standard of training and better performance. However, this was a more expensive choice. Arrangements should be made for travel and accommodation for interviewers in the distant survey areas. Interviewers had to stay for many days away from their families. All interviewers were employed full time.

(3) *Consultants*: Epidemiologic surveys need the assistance of an epidemiologist and a biostatistician.

Both will help construct the sample design, choose surveys areas, calculate the sample size, prepare dummy tables, choose statistical packages and computer software, set up the rules for data entry, editing, data analysis and design quality control procedures. A consultant biochemist is needed for biochemical studies, and an experienced BP certifier to certify the senior staff who joined the NHP for a short term. Consultants in echocardiography, duplex scanning, ambulatory BP and ECG analysis were not required since some of the NHP senior physicians were experienced in these areas.

(4) *Administrative and assistant staff:* This group included field coordinator and field supervisor, both were public health officials with previous experience in field surveys. They helped in preparatory visits, updating sample frame, making contact with local health authorities, organizing and supervising administrative aspects of the field operations and selecting enumeration areas and households. Other assistant staff included a secretary, an accountant, a purchasing clerk, a maintenance engineer, a car driver and laboratory technicians.

(5) *Local field staff:* These are local personnel recruited from survey sites on a temporary basis only during days of field operations. These included the director of local health authorities, local health clerical staff, social workers, local nurses and a local ophthalmologist (optic fundus examination).

Site preparation and purchase of equipment

Space, facilities and type of equipment employed will depend upon the size and scope of the project. It is recommended to have the project central offices in the main hospital where the PI has his or her practice. Investigators should decide whether to perform all activities in one large central site in a hospital setting or to subcontract different personnel and laboratories for services and investigations. NHP investigators elected to follow the first option. The Egyptian NHP had its site established at the University Hospital after approval of the Dean of Cairo University School of Medicine. The facilities included a conference and library room, computer room, file storage room, offices for the principal investigator, secretaries, accounting, biochemical laboratory, echocardiographic laboratory, ECG and ambulatory BP recording laboratory. The offices were equipped with a special fax and international line, powerful personal computers, BP educational materials, scales, stethoscopes and sphygmomanometers, two echocardiographic machines (a small portable one accompanying the survey team in field operations and a large unit for special studies, eg, duplex scanning), ECG machine, two ambulatory 24-h BP units, skin spectrophotometer and biochemical laboratory equipment. A van and a trailer were purchased to conduct field visits.

Questionnaire forms and other printed material

Construction of questionnaires: There are two basic approaches to collecting data, questionnaires

that the respondents fill in by themselves, and interviews that are administered verbally by researchers. In developing countries, because of high illiteracy rates interviews are recommended and questionnaire forms are filled by data collection staff (interviewers). Furthermore, interviewers can clarify questions, collect more complex answers and minimize missing or inappropriate responses.

The design and content of the questionnaire forms will depend upon the type of data collected and the demographic and environmental characteristics of the sample. After deciding upon what sort of information is required, investigators should start constructing the form for data collection. The forms should be pre-tested and validated, they usually need revision and modification during pilot studies. Questionnaire forms constitute the main research instrument and need special care in design. The following are some guidelines^{48,49} that might be helpful when constructing forms:

- (1) All forms should have instructions specifying how they should be filled out.
- (2) Collect only essential variables.
- (3) Questions should be simple, coherent, free of ambiguity and clear.
- (4) Design forms that are pre-coded, giving coded numbers to answers, eg, 1 for 'Yes', 2 for 'No', 9 for 'Do not know'.
- (5) Avoid multiple choice options, closed-ended questions are recommended with a limited number of responses.
- (6) Major subject areas should be grouped together and introduced by headings.
- (7) Use underlining, capitals, bold font for emphasis.
- (8) The investigator should read the first draft carefully as if he were a respondent to imagine all possible ways of misinterpreting the questions.
- (9) Record the amount of time required for filling the questionnaire and decide how much of it will need to be cut short for the study.
- (10) More than one form may be required.

Three different questionnaire forms (QF) were constructed by the NHP investigators.

QFI: Addressed only to the head of the family (household form). It consisted of 24 questions relating to the size of the family, housing conditions, building materials, availability of electricity, running water and questions assessing the socio-economic standard (SES) of the family.

In developing countries the assessment of SES is difficult due to a number of factors:

- (1) multiple jobbing;
- (2) reluctance to declare true income;
- (3) wide discrepancies between income, education and living standard.

In large cities sometimes it is easy to predict SES from the participant's home address or area of residence. However, this does not apply to villages and rural areas. NHP investigators developed a system to assess SES depending upon both the level of education and living standards or economic class.

Individuals in the sample belong to one of the following educational levels:

- (1) Low Level: Illiterate or just reads and writes.
- (2) Medium Level: A graduate of secondary school.
- (3) High Level: Has a university degree.

The economic status and living standard of the family were assessed through a scoring system based upon the response of the head of the household to a number of questions, each given a number of points if the answer is 'Yes'. The following are some questions in NHP-QF1 that were used to assess socio-economic class:

Do you have:

- (1) a coloured TV set? (2 pts);
- (2) a fully automatic washing machine? (2 pts);
- (3) an air conditioner? (2 pts);
- (4) more than one apartment? (2 pts);
- (5) a car? (1 pt);
- (6) more than one car? (2 pts);
- (7) Do you employ servants? (2 pts);
- (8) Do you spend your holidays in Egyptian resort(s) (1 pt), abroad? (2 pts);
- (9) Do your children go to a private school? (2 pts).

A score of zero arbitrarily defined low economic status, 1–3 points middle, 4 points or more high socio-economic. Education and economic class were given the same weight and the socio-economic status was assessed as follows:

Economic level	Educational level		
	Low	Middle	High
Low	Low	Middle	Middle
Middle	Middle	Middle	High
High	Middle	High	High

QF2: This form was addressed to all individuals in the sample frame. It consisted of 34 questions, the purpose was to identify hypertensive individuals and to have a preliminary assessment of cardiovascular and hypertension risk profile. Questions addressed marital status, religion, immigration, level of education, employment, type and nature of occupation, job satisfaction, working hours, control over work, current and past cigarette smoking and number of cigarettes, alcohol intake, history of blood testing for sugar, schistosomiasis, dietary habits (add salt to food before tasting), use of antihypertensive medications and family history of cardiovascular disease and diabetes. Women were asked about number of pregnancies and use of contraceptive pills. Attached to this form was an examination sheet describing skin colour, heart rate, BP readings, cuff size and room temperature.

QF3: This form was addressed only to hypertensive patients identified in the previous stage and gender matched controls. It consisted of 43 ques-

tions about duration, awareness, treatment and control of hypertension, type of and compliance with antihypertensive medications, use of other medications, reasons for discontinuation, symptomatology, previous hospitalization, diet, hypertensive cardiovascular complications, eg, shortness of breath, cerebrovascular accidents, transient ischaemic attacks, angina, myocardial infarction, peripheral vascular disease. Part of this form was a clinical examination sheet which covered 37 items filled by the COPs. Attached to the form were ECG, echo and laboratory sheets. Special forms were designed for substudies such as skin colour reflectance, ambulatory BP, and carotid artery ultrasound duplex scanning.

Other printed material:

- (1) Consent forms (Appendix 2 shows a copy of the front page of the consent form designed by the NHP investigators). On an additional page, there was stated the confidentiality and privacy of collected information, consent, name, signature and date.
- (2) Manual of operations and quality control measures.
- (3) Letters informing the public and health officials about the survey.
- (4) Booklet (bilingual: Arabic–English), giving information about the project in simple language.
- (5) Laboratory log book.
- (6) Interviewers' performance sheets.
- (7) Travel log book.

Training and certification of research team

Training programmes are designed for all members of the survey team particularly for the data collection staff. The goal is to standardize the measurement procedures and method of filling in the questionnaire forms and to develop new skills for some of the staff. Training will improve the consistency of measurement techniques, especially when several observers are involved. It is part of the quality control measures. At NHP, the majority of training courses were conducted by senior project physicians and included four types of courses.

(1) *Courses for newly recruited interviewers:* These took 3–4 half days and focused on the proper technique for accurate BP measurement, height, weight, waist and hip circumference, filling questionnaire forms and measurement of skin colour reflectance by a spectrophotometer. Basics of epidemiology and hypertension were also discussed. Courses were followed by practical and written examinations and certification.

All members of the survey team were trained in a standardized approach to BP measurement which included preparing the subject, applying the BP cuff, locating the brachial artery, inflating and deflating the cuff, recognizing Korotkoff's sounds and diastolic pressure (for details see Appendix 1). Certification included simultaneous BP measurement by instructor and trainee using a double stethoscope.

(2) *Refresher courses for interviewers:* Short half-day courses that were repeated every 6 months, discussing pitfalls in measurements, errors in questionnaire filling and methods of improving performance. These short courses were timed, if possible, to precede field visits. Recertification was carried out every 6 months.

(3) *Specialized courses for some of the data-collection staff:* At NHP, it was decided at an early stage to carry out data entry and laboratory procedures at central offices. Courses covered basics of computer technology, methodology of data entry, editing and quality control measures. Other courses were given to staff involved in ECG reading according to the Minnesota code.

(4) *Specialized training for senior physicians:* Carotid artery imaging by ultrasound duplex scanning to detect atherosclerotic complications of hypertension. Part of this training programme was carried out in the USA for one of the NHP investigators.

Sample design and choice of survey areas

The objective of any sampling procedure is the avoidance of biased selection. That is, each eligible case in the target population has an equal chance of appearing in the study. Thus, a sampling procedure is intended to avoid over- or under-representation of hypertensives and normotensives in the population. An ideal national hypertension population survey represents all geographic areas, and all ethnic and socio-economic groups in the country. There are a number of probability sampling designs (probability sample uses a random process to guarantee that each unit of the population has a specified chance of selection), which include: simple random, systematic, stratified random and cluster sampling. Cluster sampling is a random sample of natural groupings (clusters) of individuals in the population; it is usually done at more than one stage. This design is useful in surveys of a large population which is widely spread or difficult to enumerate⁵⁰ and it provides an inexpensive but representative sample. The NHP sampling design was a multistage probability sampling of clusters of households in selected regions representing all geographic areas and socio-economic classes of Egypt. From Egypt's most recent census conducted in 1986, a representative sample was derived through the Egyptian Central Agency of Mobilization and Statistics and from which we could estimate the prevalence of hypertension in Egypt's adult population (about 20 million in 1990). Data from pilot studies provided a preliminary estimate of the prevalence of hypertension which helped in calculating the sample size. The multistage design involved first selection of governorates, each representing a distinct region of Egypt, ie, Coastal, Delta, Frontiers, North and South Upper Egypt and Cairo. Governorates were also categorized as urban or urban-rural, based upon the demographic characteristics.

Four areas were selected in each urban-rural governorate; the capital, a village associated with the capital, a rural centre (large village: Markaz) and a

village associated with this centre. These areas were selected with probability proportional to size. In urban governorates, these areas were selected either randomly or based upon socio-economic status when possible.

Twenty-one sampling sites were selected according to this scheme. In the third stage, five enumeration areas were randomly selected in each sampling site. Within each enumeration area, one-fifth of the households were identified for the survey using a systematic sampling procedure with a random start. For more details of the Egyptian NHP sample design consult reference 41.

Sample size: In practice, the size of the study is often restricted by financial resources, the number of available cases provided from a provisional estimate in pilot studies and by time limitations. At NHP the sample size was the same in all governorates to avoid differences in the precision of the estimates from different governorates. The design included gender and ethnic groups, urban-rural and six geographic areas. Estimation of sample size requires the help of a biostatistician.

Guidelines for sample design (NHP experience):

- (1) Ensure a representative sample of non-institutional population with a reasonable age limit. The lowest age limit at NHP was 25 years. This was selected because, as in other developing countries, a major part of the population consists of children and adolescents, a group where hypertension is known to be rare.
- (2) Consider field logistics.
- (3) Optimize sample size and precision of estimates, mainly prevalence rates and odds ratios for risk factors related to hypertension.

Pilot studies

Before starting actual field operations, a number of pilot studies should be performed. The objectives of these studies are: (1) Test the response of the study subjects to interviewers and to questionnaire forms. This is critical for questionnaire development, interviewer training and the refinement of data collection procedures. Several revisions of QFs were carried out at NHP in order to improve clarity, precision, accuracy and reliability; (2) Examine behaviour and performance of data collection staff and test the outcome of the training programme; (3) Estimate the number of staff required and time necessary for different activities; (4) Test the logistics of field operations in distant areas, eg, transportation, accommodation, response of local health authorities; (5) Collect data about the distribution of BP and get a preliminary estimate of the prevalence of hypertension that helps in calculating sample size. Before starting major field operations, it is also recommended to test the different procedures in a full scale dress rehearsal.

Four pilot studies were carried by the NHP investigators. The first was on a convenience sample of five subjects from the hospital staff for the initial

exploration of the feasibility and content of the QF. The second was conducted on a small convenience sample of 10 households in a street near the University hospital. The aim was to test the reactions to various points in QF, clarity and need for modification. The third was a random sample of 200 households in a middle class district near the hospital. The aim was again to test QF, identify proper timing and duration of interviews and obtain a preliminary estimate of response rate and of prevalence of hypertension in an urban area. The fourth was carried in an urban-rural governorate in a random sample of 200 households living in mostly rural areas away from Cairo. The aim was to test the logistics of transportation and accommodation of the survey team, behaviour of interviewers, level of performance and adherence to schedule, response rates and obtaining preliminary data for hypertension prevalence in rural areas.

Quality control measures

This issue is usually neglected in studies from the developing world. It is frustrating to spend money, time and effort in collecting inaccurate and imprecise data, missing important findings and reporting wrong information. Quality control includes all the measures that are taken to assure the validity and consistency of the data. The goals of data collection and analysis are the promotion of accuracy and precision, the reduction of non-random bias and random errors and the reduction in interobserver and intraobserver variability.⁵¹ There are three main sources of error in making measurements: interviewer, subject, and instrument. These can produce a random error and less precise (reproducible or reliable) measurements. Accuracy of measurements can be compromised by the introduction of bias or systematic error produced again by the interviewer, the subject or the instrument. Quality control measures will provide strategies to enhance precision and accuracy of measurements. These measures are taken during the preparatory stage of the survey, during the field operations and after the survey at the central office. The following quality control measures were developed by NHP investigators during the preparatory stage.

(1) Preparation of 'Manual of Operations': It specifies in detail the different measurement procedures and all other methods used in the study. This will standardize the technique of measuring BP, weight, height, waist and hip, filling questionnaire forms and doing laboratory work and other investigations. It also includes the recruitment approaches, sampling design, informed consent, training and certification, content of home visit, details of field operations, equipment maintenance, methods of data entry, editing, storage and QFs.

(2) Training and certification of the research team.

(3) QFs: These were discussed previously. A reliable questionnaire is one that collects information that is replicable, relevant, complete and accurate.

(4) Regular staff meetings were held during all phases of the project for discussing planning, con-

sensus, rehearsal, performance, data, discovering and solving problems. These meetings helped in the creation and maintenance of interest and enthusiasm among NHP staff.

(5) Equipment calibration and maintenance by a qualified technician.

(6) Pilot studies.

Other administrative activities:

(1) *Review Board*: This is necessary in many countries. The board is formed of medical and non-medical personnel. They should sign a declaration approving the research procedures and the project protocol.

(2) *Approval of other health authorities*: In some developing countries, a national survey and QFs have to be approved by a number of health and security authorities before starting field operations.

Field operations

Time frame

Investigators should develop a monthly plan of field activities. The plan should include dates of preparatory visits of survey team, start and termination of different field activities. The timing of visits to different survey areas should take into consideration the weather conditions, eg, NHP survey of Aswan governorate (1200 km South of Cairo) was conducted in January, average daily temperature in summertime is 42°C. Also investigators should be aware of the local events in the survey location, eg, harvesting season, market days and festivities. During these occasions, the majority of individuals will not be available at home and a very low response rate is expected. The best time of the day for making home visits should be decided during the preparatory visits. Table 8 shows the time duration and personnel required in field operations of NHP at four Egyptian governorates.

Preparatory visits

In the NHP, the director of the local health authority of the governorate was at first contacted by the NHP field coordinator and public relations staff. The project objectives, methodology and field operations were discussed. Printed material and an information booklet would help familiarize the local personnel with the project.

A number of services were provided through the assistance of the director of the local health authority, which included recruitment of local social workers and nurses, a specialized ophthalmologist, provision of facilities for housing the survey team, when necessary, transportation and local travel of the team and the sampled population. Also, he helped in the establishment of a local health centre for detailed clinical and laboratory evaluation.

Local advertisements were made to introduce the project and survey team to the district, and announcements were made on the local TV channel to enhance the response rate (this was done in the Port-Said Survey).

Table 8 NHP field operations in four Egyptian governorates

Governorate	Type & location	No. of responders		Duration (Days)		No. of interviewers	
		Ph I	Ph II	Ph I	Ph II	Ph I	Ph II
Bani Sweif	U/R – South	1153	440	17	18	16	18
Cairo	U – Capital	1061	293	17	15	20	10
Port Said	U – Mediterranean	1296	490	19	26	18	18
Sharkia	U/R – Nile Delta	1151	355	15	22	18	9

U: Urban; R: Rural; Ph: Phase.

Updating the sample frame: Houses in the sample frame were visited by social workers and sometimes by a member of the local health office in order to identify missing households or members of the family and update the sample frame.

Names of target population, households and identification numbers were written on envelopes containing the QFs. These were distributed to interviewers by the field coordinator on the day of the survey. At least two preparatory visits were made by social workers to the households, 2 weeks and one day before the visit of the survey team. They familiarized the households with the project and notified the family about the exact date and time of the visit by interviewers.

Survey team

The NHP survey team consisted of the following staff:

- (1) Interviewers, of which the numbers varied (Table 8).
- (2) Two COPs.
- (3) Field coordinator.
- (4) Public relations person.
- (5) Lab doctor.
- (6) Lab technician.
- (7) Social worker.

Home visits during the initial screening phase were made by two interviewers, generally a male and a female doctor. This proved useful in the conservative and rural communities.

Content of home visit

The interviewers were introduced by the social worker, different procedures were explained to members of the household. Consent forms were read, a written or verbal approval was taken. Because of the high illiteracy rate, it was agreed that approval of admission into the house can replace signing a consent form. BP was measured according to a standardized protocol (Appendix 1). Two measurements were taken before and two measurements after filling the QF. The duration of the visit varied from 30–60 min depending upon the number of eligible households. Pressure readings were averaged. If the average of four readings was $\geq 140/90$ mm Hg, the individual was considered hypertensive. Members in the family known to be hypertensives and receiving antihypertensive drugs and the

newly discovered hypertensives were notified that they will be visited again by social workers, and that they will be accompanied to the health centre at a later date for a more detailed evaluation. Before leaving the house QFs were mutually edited by interviewers to check for missing data.

Local health centres

In large surveys (NHP), local health centres are needed for detailed clinical and laboratory studies. They are usually established in one of the central hospitals or clinics. It should have a central location in the surveyed governorate, easily accessible by transportation. A number of rooms should be made available for clinical examination, ECG, echo, BP and anthropometric measurements, optic fundus examination and a laboratory room equipped with a deep freezer, centrifuge, other laboratory equipment, a basin and running water.

One day before examination at the health centre, individuals were visited at home, given jars for 12-h urine collection with detailed instructions, and confirmed that they will come the next day to the centre while fasting for 12-hours. Transportation was provided when needed. A trafficking system at the health centre was designed (Appendix 3) in order to facilitate the performance of multiple and various activities for a large number of individuals efficiently and in a short time. The details of investigations were reported previously.⁴¹

Quality control in the field

The following measures were designed to enhance the response rate, improve precision and accuracy in filling QFs and reproducibility of measurements.

- (1) Preparatory home visits by social workers would enhance the response rate.
- (2) Mutual editing of QFs by interviewers during home visits would limit missing data.
- (3) Repeated BP measurements and using the mean of four readings would reduce the random error and increase precision.
- (4) Standardizing the measurement method (manual of operations) would decrease systematic errors (bias) and increase accuracy.
- (5) Inspection of interviewers' performance by senior staff in 5% of visits to assure accuracy and reliability. Interviewers' performance sheets were filled by COPs.
- (6) Revisits: The same interviewers visited the

same responders in 5% of the sample. They were blinded of the initial BP readings. COPs visited another 5% of the responders. These procedures tested the intra-observer and interobserver variability in pressure readings. Repeatability of the information assesses reliability.

(7) Call backs: Absent members of households were revisited twice to enhance the response rate. Call backs were made at some other time of day or on another day. Non-response is an important source of selection bias.

(8) Biochemical laboratory: All laboratory personnel were skilled technicians with at least 5 years of experience. For all assays, blinded duplicate analysis for intratest and intertest variabilities were performed in 10% of assays.

(9) Specialized procedures and examinations were done by qualified senior staff, eg, echo studies were performed by experienced echocardiographers with at least 5 years of training in a busy University Hospital.

(10) Echo studies were repeated in 5% of the sample by the same operator and in another 5% by a different operator. Initial interpretation was done in the field and the second interpretation of the videotaped tracings was independently performed by another cardiologist at the central office in Cairo.

(11) Measures after field operations: Staff meetings reviewed field performance and recertified research team.

(12) ECG readings: Minnesota coding system with two independent coders. Five per cent of sample was sent to professional blinded coders.

Special studies

These studies generally require special skills, sophisticated equipment and additional costs. They can be conducted on a subpopulation of the responders.

(1) *Echocardiography and Doppler*: This technique provides valuable information about cardiac involvement in hypertension. Echocardiographic measurements of left ventricular chamber dimensions and wall thickness is at present the only widely available means of detecting left ventricular hypertrophy with high sensitivity and specificity.^{52,53} Because of high accuracy, echo can be cost effective for detection of left ventricular hypertrophy.⁵² Furthermore, this technique can diagnose abnormalities in left ventricular systolic and diastolic functions, and identify regional wall motion abnormalities and myocardial scarring which are usually secondary to coronary artery disease.

The technique has its limitations and in 10% of patients, the echocardiogram cannot be analysed for technical reasons. Reproducibility and inter- and intra-observer error need to be established. NHP was the first study to conduct a large echocardiographic field survey in the developing world. Some of the NHP investigators were expert echocardiographers. It emphasized the feasibility of performing this investigative technique on a large number of individuals during epidemiologic studies.

(2) *Skin colour*: Study of the relationship between skin colour, a measure of the concentration of mel-

anin in the skin, and BP may help explain the reported increased risk of hypertension in North American black subjects.^{54,55} It is still not established whether the risk is due to a dominant genetic or environmental factors. Skin colour can be measured by a photoelectric reflectance colorimeter or spectrophotometric analysis of the skin.^{37,56} Measurements are taken from the inner aspect of the upper arm, an area with limited exposure to sun. These devices provide objective measures of skin pigmentation. Evidence of a dose-response relationship would suggest that melanin may be a genetic marker for one or more biological mechanisms involved in the regulation of BP. NHP investigators examined skin colour reflectance by a Minolta spectrophotometer on a large group of responders in a special substudy during phase II of the survey.

(3) *Ambulatory BP (ABP) recording*: Repeated BP recordings over 24-h may provide a better definition of hypertension than casual readings. Furthermore, hypertensive complications were found to correlate better with ABP readings.^{57,58} There are many types of ABP recording devices. All have to be regularly calibrated before use. BP measurements are taken every 15–60 min for 24-h. The procedure is gaining popularity in some field surveys,^{59–61} however, with NHP it was limited by the large number of required devices and sometimes the inconvenience of the procedures that led to a high refusal rate.

(4) *Vascular imaging*: Ultrasound B-mode imaging and duplex scanning of the carotid arteries is an established technique for early detection of atherosclerotic complications of hypertension.^{62,63} Carotid atherosclerosis can be silent but it carries the risk of future cerebro-vascular complications. High resolution ultrasound scans measure carotid wall thickness and identify plaques, thrombi, haemorrhages and ulcerations. The technique requires training, experience and relatively expensive equipment. At NHP, it was conducted on a small number of responders at the central laboratory in Cairo.

(5) *Other special studies*: Analysis of drinking water for lead, hardness and trace elements content might be useful in explaining variations in hypertension prevalence in different geographic areas with different sources of drinking water. There are suggestions that hard water rich in calcium and magnesium might be protective against hypertension.⁶⁴ There is an inverse relationship between calcium intake and BP.⁶⁵ At NHP, the prevalence of hypertension in Egyptian oases was significantly less than that in Cairo areas (19.9% vs 31% respectively). People in the oases drink artesian water from wells which is hard and rich in trace elements. Lead pollution in the air or drinking water was proposed as a risk factor for hypertension.^{66–69} Noise pollution can be tested and was associated with an increasing prevalence of hypertension.^{39,70} Biochemical studies such as measuring plasma insulin and glycosylated haemoglobin were performed on a subset of NHP samples. The information can help in understanding the relationship between diabetes mellitus, hyperinsulinaemia and hypertension.^{71–74} Inconsistent results of epidemiological

cross-sectional studies may result partly from racial differences.⁷⁵

Data handling

Data handling includes all the procedures of data entry, editing and analysis. It can be done either in the central offices of the project or by subcontracting an outside specialized office.

Data entry

Most data entry and analysis can be done on moderately priced microcomputers with programs that are relatively easy to use. The advantages of data handling at the central office by the project staff include:

- (1) Creating and establishing experience.
- (2) Developing a unit for data entry and statistics (this later proved to be a very important point to NHP investigators since the process of data analysis may continue for years).
- (3) Data entry and validation under direct supervision.
- (4) Guaranteeing confidentiality of entered data.
- (5) Utilizing available facilities of computers and software.
- (6) Lower cost.

The disadvantage of this approach is the lack of experience and need for training. The subcontracting of an outside experience office is more expensive and does not have the previous advantages.

Depending upon the amount of observations and variables and the extent of statistical analysis, there are at least three types of data entry software: (1) Spreadsheet software for a modest number of observations. (2) Database management software for a large number of variables and editing interactively, i.e., clean the data while they are being entered. (3) Statistical software that bypasses the spreadsheet and database management software and enters data directly into a statistical analysis program.

NHP investigators decided to perform data entry and analysis at the central office under the supervision of a committee chaired by the project biostatistical and epidemiological consultant. Consulting experts were recruited for validation of data entry, solving logistic problems and performing complicated statistical analysis. Two supervisors were selected from NHP senior staff who had experience in computer work to take the responsibility of preparing database files and preparing them for data entry, training and supervising operators, solving logistic problems, cross-validation of data entry and checking for the validity of data (see quality control). The data entry staff were selected from the interviewers who showed interest in computer work; they were trained and tested by the supervisors. Most data entry and analysis was done using moderately priced IBM computers (Everex 486/33) with programs relatively easy to use (Database III plus and (SS)). Database management programs were found appropriate for NHP requirements. They can check each value as it is entered to be sure that

it is in the permissible range, reducing the problem of widely aberrant values eg, a value of >300 for BP is not entered. While using database, every question or variable was given a name that identified its field (place) in the data set. The computer screen was set to appear similar to the QF, which helped the operators. For each question in QF, every possible response was coded with a number that can be entered into the computer, eg, 'Don't know' response was coded '9'.

Sources of errors during data entry: There were two types. The first was related to the filling of the original questionnaire forms (comprised 90% of errors). The second was related to data entry in the computer (10% of errors). The following are causes of errors related to questionnaire forms:

- (1) Misunderstanding of questions by the interviewers;
- (2) Coding system not clear;
- (3) Missing answers.

Errors related to computer data entry resulted from the human factor of fatigue and this was solved by developing the techniques of range validation, cross-validation and quality control measures.

Quality control

The following are quality control measures applied by NHP investigators for data entry.

(1) Before data is entered into the computers, a group of the research team edits what is written in the forms at the central office, checking the completeness and appropriateness of the entries.

(2) Range validation: Only permissible ranges are allowed. The computer is programmed to beep and reject any entries outside the ranges defined, eg, 0 kg for weight.

(3) Cross-validation: Data which do not cross-validate are rejected, eg, number of cigarettes per day in a non-smoker.

(4) Double entry: Important data, eg, BP, are entered twice and both entries are checked for matching or calculating the difference between the same variables. A difference which is not equal to zero means an error that is easily located.

(5) Ten per cent of complete data are entered twice and checked for matching.

Statistical analysis

Two statistical approaches are used in the analysis of collected data, descriptive and analytic.⁷⁶⁻⁷⁸

Descriptive statistics: The aim is to characterize study subjects by looking at distribution of variables one at a time. The following are some of the methods used in descriptive statistics: (1) Frequency distribution depicted as histograms and line graphs, putting the value of one variable on one axis and the frequency with which that value appears on the other axis; (2) Measures of central tendency such as the mode, mean and median; (3) Measures of dispersion such as percentages, proportions, variance,

standard deviations, standard error and confidence intervals.

Analytic statistics: The aim is to look for differences between groups and for associations among variables in the study. Some of the methods used were: (1) Comparison between groups, eg, hypertensives and normotensives, and between subgroups, eg, men and women, urban and rural, different age groups, groups defined by absence or presence of risk factors; (2) Correlation between variables, eg, age or body weight vs BP; (3) Cross-tabulation, eg, two-by-two tables used to compare the proportion of hypertension in two different exposure groups and estimation of relative risk and odds ratio; (4) Analysis of variance for multiple comparison procedures.

The following is a good approach when analysing data collected in a hypertension survey.

(1) Sample characteristics: Size, response rate, age, gender and regional distribution (rural, urban, different geographic areas). Other demographic characteristics include housing conditions, (eg, with running water, electricity), level of education, socioeconomic groups, skin colour, employment, etc.

(2) BP distribution and hypertension prevalence according to age, gender, regional, urban and rural groupings and demographic characteristics. Hypertension classification (stages) – JNC V.⁷⁹ Awareness, treatment and control of hypertension.

(3) Prevalence of hypertension risk factors in normotensives and hypertensives and in different subgroups (eg, age decades, men and women, etc).

(4) Correlation between hypertension risk factors and BP level and prevalence of hypertension.

The last step in the analysis of data is weighting, that is translating the figures and prevalence rates in the sample into national estimates representing the entire population. This process requires the help of a professional statistician.

Reporting and publishing

A reporting system is an integral part of the survey. Reports are generated by the research team, discussed during meetings, sent to a funding agency, and when appropriate, to national health authorities and the scientific community. In collaborative health programmes, some of the reports are jointly prepared and sent to all investigators. The following are the different types of reports that were prepared by NHP investigators:

- (1) consensus reports, eg, definition of heart failure or left ventricular hypertrophy;
- (2) progress reports;
- (3) subcommittee's reports;
- (4) field reports;
- (5) fiscal reports;
- (6) annual reports;
- (7) mid-term report;
- (8) joint report with collaborating foreign agency (NHLBI);
- (9) final report.

Before data entry is completed and a statistical

analysis is in progress, investigators can start giving reports of preliminary results. Then they should put a list of papers that deserve priority for publication. It is recommended to have a writing group chaired by the principal investigator that defines a publishing policy. The papers that deserve priority are those that discuss design, methodology and hypertension prevalence data.

Collaboration with scientific foreign organizations

The majority of developing countries lack funds and expertise for conducting large national hypertension surveys. Help and cooperation through foreign scientific organizations from western or more developed countries should be encouraged. A collaborative health programme is ideal. The foreign country, besides being the main source of funding of the survey in the developing nation, can provide scientists and technical support, eg, help in training and certification of the survey team, advice regarding sample design, construction of questionnaire forms and quality control measures. They can share in the supervision of field activities, statistical analysis of data, generating reports and manuscripts and organizing joint symposia and conferences. A foreign visiting exchange programme should be part of the collaborative project. Members of the national investigative team visit the foreign institution to meet with collaborative experts for consultation, attend seminars or join specialized training courses. Foreign scientists pay exchange visits to the developing nation, visit survey areas, help solving logistic and technical problems, lecture and share in local conferences and writing groups. The Egyptian NHP is a successful example of these collaborative health programmes between Egypt and the USA.

What is next?

A question that is always brought up after completing the survey and starting publishing the data, 'What is the next step?' This is an important question particularly if the data in the survey identify a large national hypertension problem. Investigators should start working in different directions. The first is communication. They should inform the national media and health authorities through writing and direct contact about the results of the survey. The NHP principal investigator wrote to and met personally with a number of Egyptian journalists and media personnel. They were informed about the results of NHP. The principal investigator talked on more than one occasion at the local Rotary Club about NHP. Also, the principal investigator wrote to and met with three different Egyptian ministers of Public Health and the Ministry of Health regional WHO office director. He explained the NHP and the magnitude of the problem. NHP main results and publications were sent to ministers of education, scientific research and local government, deans of medical schools and presidents of medical societies. At annual national scientific meetings, NHP data

were discussed. Public officials and health planners began to realize the magnitude of the problem of hypertension. Communications helped the second direction which is the formation of a National Hypertension Society or League. The Egyptian Hypertension Society was a direct byproduct of the Egyptian NHP. Fund raising campaigns were initiated to support physicians and public hypertension education programmes. Through lectures, meetings, and printed material, both the public and physician became aware of hypertension as a national problem.

Information provided should stress the following points: (1) Magnitude of the problem in the nation and in the different segments of the population; (2) Risk factors that contribute to the development of hypertension; (3) Hypertension can be prevented through public education programmes. Recommendations for the food industry should be developed. There is evidence for a significant BP-lowering effect of reduced sodium intake. A goal of less than 6 g sodium chloride per day is recommended and achievable;²² (4) Hypertension can be easily detected and treated; (5) Hypertension can cause complications and death if not diagnosed and treated; (6) Costs of undetected and untreated hypertension include disability, hospitalization and loss of working hours; (7) Other cardiovascular risk factors should be corrected. In another direction, investigators can start cohort or longitudinal studies with the aim of identifying hypertension risk factors and reasons for intrapopulation and regional variations in hypertension prevalence.

These different actions will establish national preventive programmes, better patient care and a healthier society.

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Appendix 1: Recommended steps for BP measurement

Before taking BP

- (1) Explain the procedure to the patient.
- (2) The patient should not talk during the procedure.
- (3) The observer should be in a comfortable, relaxed position.
- (4) The urinary bladder should be emptied at least 30 min prior to the measurement of BP.
- (5) Wait for at least 30 min after eating; 2 h in the elderly.
- (6) Smoking and caffeine should be avoided at least 2 h before BP measurement.
- (7) The patient should rest at least 5 min in a quiet, comfortable environment before BP measurement.
- (8) The temperature of the examining room should be comfortable.

Technique of BP measurement

- (1) Support the patient's arm so that it is at the heart level.
- (2) Remove any restrictive clothing from the arm and expose the area of the brachial artery.
- (3) Choose an appropriate cuff size.
- (4) Ensure that the sphygmomanometer is at eye level.
- (5) Palpate the brachial artery and centre the bladder over the artery.
- (6) Wrap cuff snugly around the arm so that the edge of the cuff is 3 cm above the crease of the elbow.
- (7) Determine the level of the maximal inflation by palpating the radial or brachial artery and rapidly inflating the cuff until the pulse is no longer palpable. Note this pressure on the sphygmomanometer and add 30 mm Hg (maximal inflation).
- (8) Rapidly deflate the cuff and wait 30–60 s before re-inflating.
- (9) Place the stethoscope gently over the brachial artery.
- (10) Rapidly inflate the cuff to the maximal inflation level.
- (11) Release the air in the cuff so that the pressure falls at a steady rate of 2 mm Hg per beat.
- (12) Do not re-inflate the cuff once the air is being released to recheck either systolic or diastolic pressure.
- (13) Note the systolic pressure at the onset of two consecutive beats, and diastolic pressure at the point at which the sounds disappear (Phase V).
- (14) Read the pressure to the closest 2 mm Hg and mark at the manometer.
- (15) Listen for at least 10–20 mm Hg below the last sound to confirm disappearance, then deflate rapidly.
- (16) If sounds persist to zero, or close to zero, use the muffling of sounds (Phase IV), to indicate diastolic pressure.
- (17) Note any auscultatory gap or irregular pulse. If sounds are heard close to zero, record both Phases IV & V.
- (18) Record patient's position, cuff size and areas used for measurement.
- (19) If sounds are difficult to hear, ask the patient to elevate his arm, reposition the arm and relocate the brachial artery by palpation.
- (20) Wait for 30–60 s and repeat the measurement again and take the average.
- (21) If the first two readings differ by more than 5 mm Hg, an additional reading should be obtained and the average taken.
- (22) Ask the patient to stand and repeat BP measurements.

Appendix 2



Consent Form

Project Title: The National Hypertension Project (NHP)

Principal Investigator: Dr. M. Mohsen Ibrahim, Professor of Cardiology, Faculty of Medicine, Cairo University

Purpose of Research:

This project aims to investigate the prevalence of hypertension among Egyptians and to attain precise statistical results to aid health planners set an accurate health policy and allocate technical and financial resources accordingly.

Investigation of different environmental, hereditary, social and economic factors will help determine which factors lead to the coming on of this disease, and which sectors of the population are more susceptible to being affected by such a disease and/or its dangerous complications.

This is of great importance as hypertension, if neglected in the diagnosis or treatment stage, can lead on the long term to kidney failure, brain haemorrhage, paralysis, heart failure, and early artery sclerosis.

Health planners may also utilize scientific data derived from this study for setting ways for prevention of this disease in its early stages.

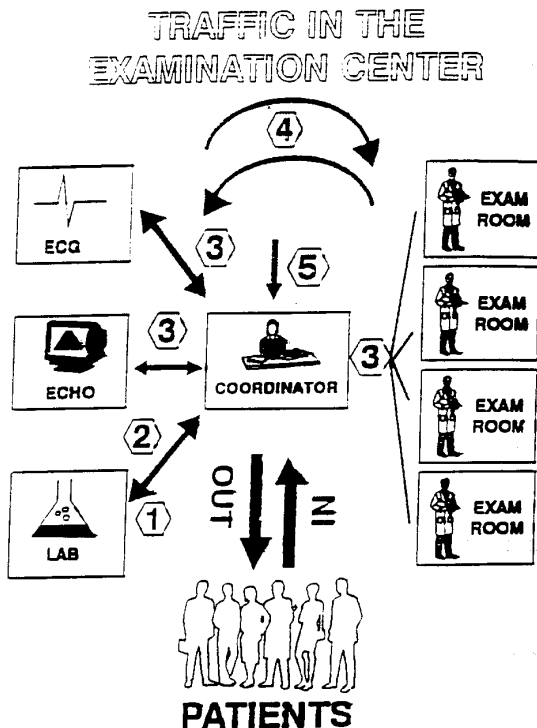
Research Stages:

On my consent to participate in this study I am fully aware of the procedures to be followed by the interviewing research team, which are to be made free of charge, and include: answering a number of questions on my health condition and socio-economic status within a time period of 15 minutes; undergoing measurements for blood pressure and pulse repeatedly, and weight and height. In case I am found to be hypertensive the research team will contact me on a following occasion for further medical investigations, including complete medical check up, electrocardiography, echocardiography, and blood and urine sampling which are necessary for finding the causes for hypertension, its effect on vital body organs, and if there are any other diseases that could interfere with the recommended treatment.

Benefits to be Gained from My Participation in the Research:

The benefits I am to personally gain are that I am to know my blood pressure level, if I am hypertensive or not, and in case I am hypertensive what is the treatment particular to my case. With note that hypertension does not cause any complaints to the patient and that the only way for

Appendix 3



Appendix 4: NHP team

Principal Investigator:
Prof M Mohsen Ibrahim

Assistant to Principal Investigator:
Dr Hussein Rizk

Clinical Investigators:

Dr Amel Khalifa
Dr Hassan Khaled
Dr Hatem El-Atroush
Dr Hossam Kandil
Dr Karima Hassan Khalil
Dr Khaled Ziyada
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Dr Saad Farrag
Dr Salwa Morcos
Dr Sameh Zaghoul
Dr Sherif Helmy
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Dr Wael Abdel Aal
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Field Coordinators:

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Consultant Epidemiologist:

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Dr Paul Whelton
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Ministry of Health Doctors (Interviewers):

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Dr Amira Salah El-Din El-Badrawy
Dr Azza Barakat Sorour
Dr Emad El-Din Mohamed Ahmed
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