AN IMPLEMENTATION ON USE OF HANDHELD TECHNOLOGIES IN MEDICAL RESEARCH AREAS: HEALTH HABITS AND HISTORY QUESTIONNAIRE ON A POCKET PC

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Approval of the Graduate School of Informatics

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ABSTRACT

AN IMPLEMENTATION ON USE OF HANDHELD TECHNOLOGIES IN MEDICAL RESEARCH AREAS: HEALTH HABITS AND HISTORY QUESTIONNAIRE ON A POCKET PC

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In most of the studies, face to face interviews are required with individuals for data collection and hence to apply questionnaires. There are two methods for applying the questionnaire; the paper-based and the electronic method. The paper-based method takes time and is of a high cost to the researchers. Because of writing/reading based errors, this method may cause inaccuracy in collected data. On the contrary, conducting questionnaires in electronic environment procures savings in cost and time, improves data accuracy, gives faster results, and increases efficiency.

However, in this method some problems may arise in surveys conducted in urban areas, i.e. problems related to communication and network infrastructure. Nevertheless, advances in Information Technologies provide mobile data collection and computing, and hence they have become a significant place in every part of our life. Many researchers have begun to prefer using these developing technologies in their studies since using mobile devices in conducting health surveys is more useful and economical than the paper-based questionnaires.

In this thesis, we have developed a mobile device-based questionnaire, which is an adaptation of the one used by the National Cancer Institute of USA in paper-based form. In other words, in this work the "Health Habits and History Questionnaire" has been adopted to the pocket PCs. It is planned to be used for an ongoing epidemiological study in Çukurova region. We hope that this study will be an example for the similar studies in the future.

Keywords: Medical Research, Mobile Questionnaire, Pocket PC

ÖZ

TIP ALANINDA TAŞINABİLİR TEKNOLOJİLERİN KULLANIMI HAKKINDA BİR UYGULAMA: CEP BİLGİSAYARINDA BESLENME ALIŞKANLIKLARI VE YAŞAM TARZI ANKETİ

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Bilimsel araştırmaların birçoğunda veri toplamak, araştırmaya dahil edilen bireyler ile yüz yüze görüşmeyi ve bu bireylere anket uygulamayı gerektirmektedir. Anket uygulamak için iki yöntem vardır, birincisi kağıt tabanlı yapılmakta ikincisi ise elektronik aygıtların kullanımını gerektirmektedir. Kağıt tabanlı anket uygulamalarında anket doldurma sürelerinin uzunluğu, yüksek maliyet ve anketin doldurulması ve elektronik ortama aktarılması sırasında yapılması muhtemel hatalar gibi dezavantajlar ortaya çıkacaktır. Buna karşın, elektronik olarak gerçekleştirilen

uygulamada maliyetin düşüklüğü, uygulama süresinin kısalması, verilerde kayıt doğruluğunun artışı ve sonuçların hızlı bir şekilde elde edilmesi önemli avantajlar sağlamaktadır. Anketlerin yapılacağı mekanlar dikkate alındığında ise ulaşım ve ağ altyapısı sorunları ortaya çıkmaktadır. Bilgisayar teknolojilerindeki gelişmeler taşınabilir (mobil) sistemlerin hayatımızın her alanına girmesini sağlamıştır. Birçok araştırmacı da çalışmalarında bu teknolojilerin kullanımını tercih etmeye başlamıştır. Veri toplamak için kullanılan anketlerin taşınabilir elektronik cihazlar yardımıyla yapılması kağıt tabanlı yönteme göre hem daha kullanışlı ve hem de daha ucuz bulunmaktadır.

Bu çalışmada "Ulusal Kanser Enstitüsü" (National Cancer Institute, USA) tarafından hazırlanan ve halen kağıt tabanlı olarak uygulanmakta olan "beslenme alışkanlıkları ve yaşam tarzı" ile ilgili bir anketin, cep bilgisayarlarına uyarlanması yapıldı. Bu uyarlamanın Çukurova bölgesinde önümüzdeki yıl veya yıllarda yapılması planlanan bir saha araştırmasında uygulanması düşünülmektedir. Çalışmamızın gelecekte benzer çalışmalarda da cep bilgisayarlarının kullanımına ışık tutacağı kanısındayız.

Anahtar Kelimeler: Cep Bilgisayarı, Mobil Anket, Tıbbi Araştırma Alanı

To My Father,

For your endless support and love

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To my husband, İlker, I offer sincere thanks for his unshakable faith in me and his willingness to endure with me the vicissitudes of my endeavors. He helped me in every phase of the thesis with his knowledge. I would never finish this study without his endless support and love.

Finally, my deepest thanks are to my mother, father and brothers for understanding my frequent absences, motivating me and giving me support in every pace of my life.

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LIST OF ACRONYMS AND ABBREVIATIONS

CAB	**Cab**inet (Microsoft Windows File Extension)
CAFE	**C**omputer **A**ided **F**ield **E**diting
CAPI	**C**omputer **A**ssisted **P**ersonal **I**nterviewing
CDC	**C**enters for **D**isease **C**ontrol and Prevention
CDHAM	**C**enter for **D**isaster and **H**umanitarian **A**ssistance **M**edicine
CE	**C**ompact **E**dition
EPIC	**E**uropean **P**rospective **I**nvestigation into **C**ancer and Nutrition
FDCS	**F**ield **D**ata **C**ollection **S**ystem
GPRS	**G**eneral **P**acket **R**adio **S**ervice
HHHQ	**H**ealth **H**abits and **H**istory **Q**uestionnaire
HTML	**H**yper **T**ext **M**arkup **L**anguage
IDE	**I**ntegrated **D**evelopment **E**nvironment
IT	**I**nformation **T**echnologies
M2B	**M**other-**to**-**B**e
MB	**M**ega **B**yte
MCAPI	**M**obile **C**omputer **A**ssisted **P**ersonal **I**nterviewing
MNQ	**M**obile **N**utrition **Q**uestionnaire

MQ	**M**obile **Q**uestionnaire
MS	**M**icro**s**oft
NCHS	**N**ational **C**enter for **H**ealth **S**tatistics
NCI	**N**ational **C**ancer **I**nstitute
NHANES	**N**ational **H**ealth **a**nd **N**utrition **E**xamination **S**urvey
NSPCC	**N**ational **S**ociety for the **P**revention of **C**ruelty to **C**hildren
OS	**O**perating **S**ystem
PC	**P**ersonal **C**omputer
PDA	**P**ersonal **D**igital **A**ssistant
RAM	**R**andom **A**ccess **M**emory
ROM	**R**ead **O**nly **M**emory
SD	**S**ecure **D**igital
SDA	**S**mart **D**evice **A**pplication
SURE	**SU**rvey **R**esults **E**ntry
TBSA	**T**otal **B**ody **S**urface **A**rea
USARIEM	**U**.**S**. **A**rmy **R**esearch **I**nstitute of **E**nvironmental **M**edicine
XML	E**x**tensible **M**arkup **L**anguage
XSD	**X**ML **S**chema **D**efinition

CHAPTER 1

INTRODUCTION

1.1 Motivations of the Study

In order to collect useful data, applying questionnaire is the most widely used method in some of research areas. For many decades, questionnaires have been used for evaluating focus groups' knowledge about a certain subject/product, making a preliminary attitude study before introducing a product/subject or collecting data to use in an academic research. Unfortunately, it is always a problem both to apply and to evaluate these questionnaires. There are two types of questionnaires, paper-based and electronic-based. Electronic based questionnaires can be done by using desktop computers, laptops or other devices.

One of the reasons of facing these difficulties is the nature of the application of the so called paper-based questionnaires which requires paper documents to be filled-in and interviewing people either face to face or on the phone, which prolongs the

evaluation. In some research areas like medicine, getting the outcome of a study in a short time is very essential when the purpose of the study is taken into consideration. Thus, when the time is an important factor, researchers (if possible) may not prefer to use paper-based questionnaires.

As an alternative to the paper-based questionnaires, the electronic-based questionnaires on desktop computers (hereafter will be referred, simply, as desktop-based questionnaires) are suggested. However, the need of applying the questionnaires anytime and anywhere limits the usage of this method, too.

1.2 Problem Statement

As stated above, the total time of the study increases due to the nature of the paper-based method in questionnaire application. This method prolongs the application and evaluation phases of a survey owing to the interviewer-based recording errors and the transfer of data into an electronic environment.

The poor handwriting of the interviewers will cause problems in data entry, because, it will be hard to read and record the answers to open-ended questions. Also, since surveys are conducted to a large number of people, too many data entries should be made, and so during entry without being aware of some questions may be passed. In addition, because more than one interviewer is engaged for applying a questionnaire, each may give an unacceptable answer or an answer that is not applicable.

Another problem may be faced due to the consistency. The interviewer should not ask the questions that have to be skipped. When one of the problems stated above appears interviewers should again return to the respondent and repeat the questions (to him/her) which are thought to have been answered wrongly. Thus this takes time and costs too much. If it is impossible to contact the respondent, the questionnaire should be re-applied to another individual.

In the method mentioned above, the questionnaire is done on paper but for the evaluation phase the data must be converted into electronic format, so time is needed for this work, too. When the data are improperly entered because of interviewer-based errors stated above, reporters would spend a great deal of time to clean the data which would cause a far more time wasting problem than converting data into electronic format.

In addition to the time wasting problem, the psychological impact of the paper-based questionnaires is a serious problem, too. Most people do not want to answer the questions properly in a survey questionnaire because of the loaded pages. Altough some of the questions have to be skipped due to the answers of previous questions, in this method one may read all the questions.

Questionnaires in medical studies are mostly applied about a subject that may affect or be related to patient's health and/or to understand more about the causes of disease. The time factor is very important especially for medical studies, since every study might be useful for the prevention of a disease.

To ease these problems, an alternative approach, known as desktop-based questionnaires, can be proposed, which provides the electronic data collection and entry [1]. However, for this method, different problems may occur due to the survey areas, and portability requirements of the devices used. In an urban area, problems may arise about communication, network infrastructure and transportation of the devices. Since 1990's laptop computers have been used to overcome these transportation problems. But they have had similar requirements like desktop computers, like a table or lap for the unit to be placed while the user works, and they need a regular power supply for long time uses. Furthermore, the costs of electronic questionnaires on personal computers (PCs) or Laptops are high.

To handle the problems stated above in the paper-based and the desktop-based questionnaires, alternative methods should be tested. In order to make useful studies, reliable data must be received quickly from the surveys.

1.3 Proposed Solution

None of the methods stated in the previous section solves all the problems mentioned above. In this thesis, a different method is proposal that can potentially result in error free data collection in a shorter time and at a lower cost, make it easier to coordinate the answers of focus groups who will participate in a survey, expedite the evaluation phase as quickly as possible, and furthermore make the application possible anytime and anywhere.

Advances in Information Technologies (IT) provide mobile computing to become a significant place in every part of our life. Many researchers prefer to use these developing technologies in their studies [2]. In addition, all the purposes stated in the paragraph above can be realized by mobile questionnaires. In this thesis, a mobile computing device implementation of a questionnaire, which is still in paper-base use, has been done. The questionnaire is named as "Health Habits and History Questionnaire" (HHHQ) and it has been prepared by the National Cancer Institute (NCI) [3]. The implemented "**Mobile Questionnaire**" is planned to be used for an epidemiological study in Çukurova region by the *Department of Biostatistics*, *Faculty of Medicine*, *Çukurova University, Adana, Turkey.*

1.4 Organization of the Thesis

The thesis is organized as follows:

Chapter 1 defines the motivation of the study, states the problems faced related to this work, and states the proposed solutions to those problems.

Chapter 2 discusses the key concepts of the thesis, theoretical background, technologies and techniques used in the design of the Mobile Questionnaire. It also summarizes the related systems previously established.

Chapter 3 describes the assumptions and constraints of the Mobile Questionnaire. Also, detailed information about the HHHQ, and finally the design of the Mobile Questionnaire intended in this work is presented and discussed in that chapter.

Chapter 4 gives the implementation details of the Mobile Questionnaire. In that chapter, we also give an application of the questionnaire to a small number of people as well as its cost analysis.

Finally, Chapter 5 concludes the thesis with a discussion and points out several challenges and future work related to this study.

CHAPTER 2

RELATED WORK

This chapter provides the details of the literature survey. In Section 2.1, the key concepts, theoretical background, technologies and techniques used in the idea and design of the "Mobile Questionnaire" (hereafter it will be refered as MQ) are briefly summarized. Some MQs that have been done before and survey software for designing MQs are reviewed in Section 2.2.

2.1 Foundations and Technologies

A MQ reduces the time elapsed throughout the collection and analysis of data, and makes it possible to capture correct data. Furthermore, the application requires running on commercially available hardware and operating system (OS).

In this section, the emerging technologies that form the application, basic concepts and theoretical background, are briefly summarized. For this purpose, surveys and questionnaires, some surveys related to health and nutrition, mobile computing

devices, the usefulness of mobile the computing devices in surveys and Microsoft Visual Studio .NET 2003 are stated.

2.1.1 Surveys and Questionnaires

A survey is a method of gathering information from a population. It is called a *Census* if it includes almost all the population and a *Poll* if it has as an objective of public opinion or politics, and a *Health Survey* if it includes only a sample of the population and is related to a public health question. A survey must have an objective. To be of any use, the survey must be able to provide accurate information to answer the posed objective and/or the question of interest. It must be of the proper size to have enough power. It must ask the proper questions in a clear and concise way. It must not suggest the answer in the questions and waste effort in questions not related to the main objective. This means that the survey *must return the true answers of* the population from which it was drawn [4].

Before designing a survey the following points should be done [4];

- Define the questions to be answered.
- Define the sampling strategy.
- Define and test the questionnaire.
- Train the field workers.
- Define the techniques for cross-validation.
- Define the final analysis.

After designing the survey, the verification and cross-validation of the questionnaire and checking of the survey schedule and budget should be done. When the survey is finished all the data must be cross-checked again, the main analysis should be performed, and finally any exploratory data analysis should be done [4]. The flow chart of a survey can be seen in Figure 2.1.

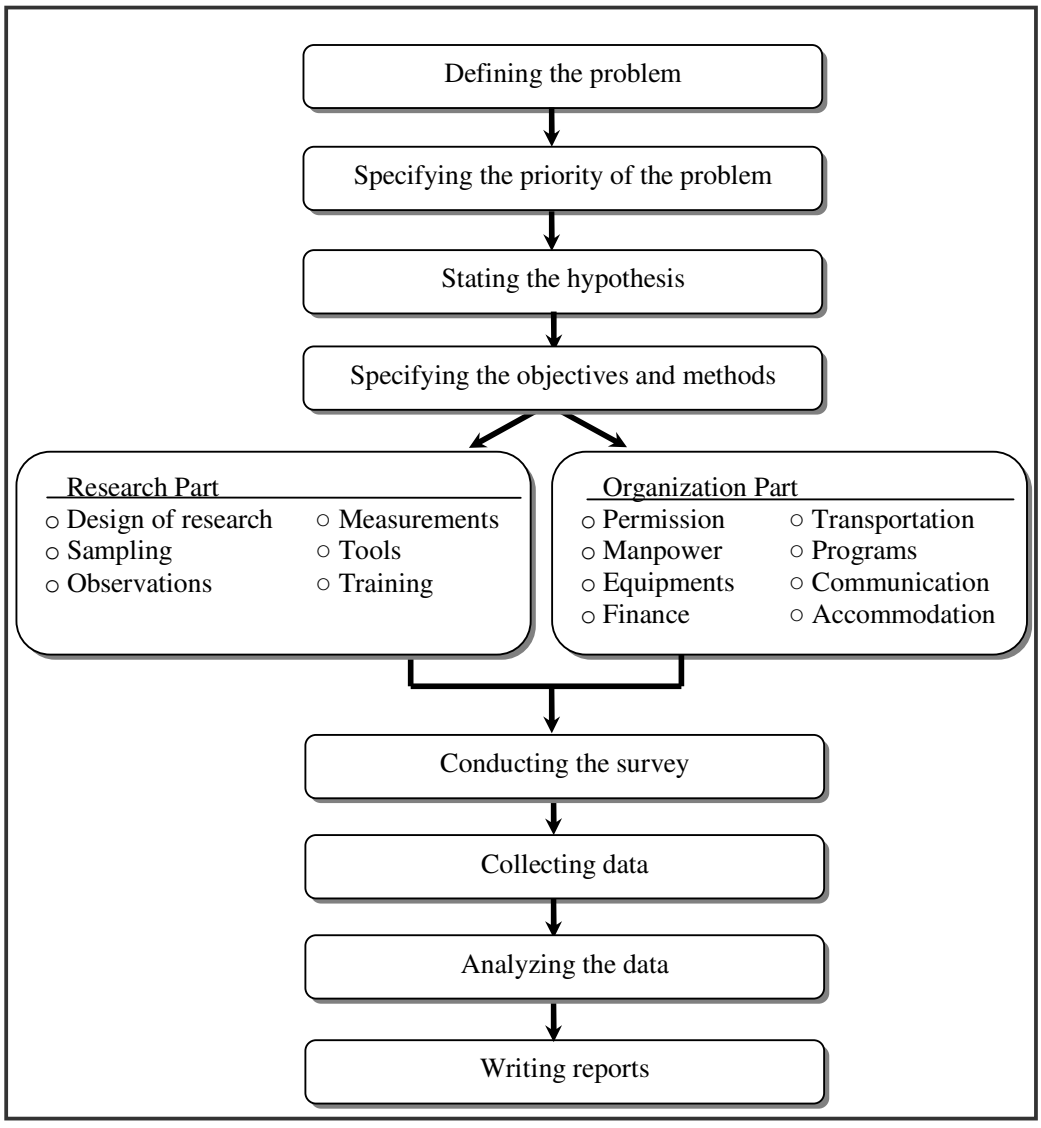

Figure 2.1 Flow Chart of a Survey [4]

There are different ways to collect data in a survey [5];

1. *Literature search*: It involves reviewing all readily available materials like, newspapers, magazines, annual reports, company literature, on-line data bases, and any other published materials.
2. *Talking with people*: This method can be used in the initial stages of a study. If the subject is exceptionally new and can not be found in the literature, this method can be used, but the information has questionable validity. This is because, it is highly subjective and might not be representative sample of the population.
3. *Use of Focus Group*: It is used as a preliminary research technique to explore people's ideas and attitudes, but in this technique the sample is small and may not be representative of the population in general, like the technique of *talking with people*.
4. *Personal interview*: It involves one person interviewing the other person for personal or detailed information. The interviewer asks questions from a written questionnaire and records the answers. This is mostly used when the other methods are not suitable for the specific research.
5. *Telephone surveys*: It is a fast method to gather information from a large sample. The interviewer follows a prepared script, like a written questionnaire.
6. *Mail surveys*: This is a cost effective method for larger samples. The main disadvantage of this technique is the inability to probe respondents for more detailed information.
7. *E-mail and Internet surveys*: This is the most cost effective and fastest method of conducting a survey, but the demographic profiles of the Internet users do not represent the general population.

In surveys, the collection of data takes the longest time. Sometimes, this period of time can be much longer than the predetermined time, i.e., the survey schedule can not be obeyed. In addition, during the collection of the data some errors based on the interviewers may be made (poor handwriting of the interviewers, giving unacceptable answers, passing some questions without being aware of, etc.). These errors result in unexpected results from the survey. After the collection, the data must be converted into electronic form. At this stage, some data may be entered incorrectly or incompletely. For the success of researches all problems mentioned above should be eliminated.

In this study, a newly introduced method, the so called MQ method will be, used. The MQs come as a solution to most of the problems stated above. The advantages of gathering information by mobile computing devices will be introduced in Section 2.1.3. However, in the next section, first, some popular surveys about health and nutrition will briefly be summarized.

2.1.2 Some Surveys Related to Health & Nutrition

In this section, we will discuss surveys related to health and nutrition which have been conducted in several countries.

A few of the well known surveys on this topic are the National Health and Nutrition Examination Surveys I-II and III (NHANES-I, NHANES-II and NHANES-III)

which were conducted by the National Center for Health Statistics (NCHS) [6]. The central purposes of these programs were to measure and monitor the health and nutritional status of the people of the USA. NHANES-I was conducted between 1971 and 1974, NHANES-II between 1976 and 1980 and finally NHANES-III between 1988 and 1994. The data were obtained by interview and examination, and included a 24-hour dietary recall, a limited food frequency questionnaire, physical examinations, anthropometric measurements, and laboratory analyses of blood and urine specimens.

In NHANES-I and II projects and in the first four year of NHANES-III, the household questionnaire data were reviewed manually by field editors and interviewers. By the introduction of the computer-assisted personal interviewing (CAPI-will be described in Section 2.1.4), desktop-based questionnaires were used between the years 1992 and 1994. The data of the interview and examination components were recorded directly onto a computerized data collection form. With the exception of a few independently automated systems, the system was centrally integrated. This operation allowed for ongoing monitoring of much of the data. The CAPI questionnaires featured built-in edits to prevent entering inconsistencies and out-of-range responses.

The European Prospective Investigation into Cancer and Nutrition (EPIC) is another comprehensive study done on the subject of health and nutrition [7]. EPIC is a multi-centre prospective cohort study designed to investigate the relation between diet, nutritional and metabolic characteristics, various lifestyle factors and the risk of

cancer [7]. This study is based on 22 collaborating centers in nine European countries (UK, Germany, Netherlands, France, Italy, Spain, Greece, Denmark and Sweden).

The potential study subjects were contacted in each study centre using various methods adapted to the local target population (letter, phone, personal contact). The questionnaires on diet and lifestyle were either mailed to subjects or given by hand during one of the personal contacts which were arranged with all study subjects in order to take anthropometric measurements and blood samples. Questionnaires were used for direct interviews by a dietician. Besides being easy to fill out, most of the questionnaires were designed to be read by optical scanning or otherwise had to be designed for quick manual data entry, which implied the extensive use of pre-coded options for answers [8]. For instance in the EPIC study carried out in Germany, the Food Frequency Questionnaires were filled by study participants and read by an optical scanner [9].

The EPIC and NHANES projects were applied on a large number of subjects. The total EPIC sample was more than 400,000 middle-aged men and women. The NHANES-II had been administered to approximately 20,000 persons over a 4 year period, and the NHANES-III to 40,000 persons over a 6 year period. Using the paper-based questionnaires in the data collection stage of these comprehensive studies had many disadvantages. Therefore, alternative methods were used, like reading the forms by optical scanners or using the CAPI questionnaires.

2.1.3 Mobile Computing Devices

A mobile computing device (hereafter will be referred, simply, as a mobile device) is a small, portable computer that allows one to store, organize, and access information. A mobile device can run on a number of operating environments, including a compact version of Microsoft Windows and Linux, as well as on environments that are not available on desktop computers, such as the Palm OS and Research in Motion's RIM OS.

A mobile device can be referred to as a "Handheld PC, Palmtop, Pocket PC, Palm or Personal Digital Assistant (PDA)", but in this study it is understood as a PDA. We mean to use Pocket PC for PDAs' running Microsoft OS (such as Compaq iPaq) [10] and Palm for PDAs' running Palm OS (such as Palm VIIx, Palm VIIIc).

A PDA may feature a scaled-down keyboard, a pen-like stylus, or both. Mostly they are pen-controlled devices, with networking, and some even with voice recognition abilities. The most common input method for a PDA is the touch-sensitive screen used in conjunction with a pen-like stylus and an on-board character recognition software. The display screen is used as an output unit, as in regular desktop computers. The screen is quite small and is monochromatic or colored. PDAs are powered by rechargeable batteries. Because of their physical size and weight they can be used easily in all areas.

A PDA has a processor and a combination of ROM, RAM and storage cards for the storage and processing of any data. PDA's do not have hard drives so the OS and other built-in applications are stored in ROM, so they do not take up active RAM space. RAM is used to store additional applications and all of ones data. Nowadays, PDA's have 32 MB or more memories. Storage space can, however, be greatly increased with the use of expansion cards, such as, Compact Flash, Secure Digital (SD) or memory sticks.

Those devices are not just personal organizers; they also offer absolute portability, extended battery life, an intuitive interface, and surprising computing power. They can be interconnected to desktop computers to provide a mobile interface with standard software applications. In addition, modem and wireless communications make the data transfer to and from the field.

As a result, we can say the most important characteristics of PDAs are that they are small and easy to use, have long battery life, and have wireless capabilities. Therefore, one can state that the potential utility of the mobile devices for field studies is tremendous.

2.1.4 Usefulness of Mobile Devices in Surveys

As stated before, a computer-assisted data collection in survey research offers potentially lower costs, quicker turnaround time, and improved data quality as

compared to the traditional paper-and-pencil methods [1, 11, 12]. A computer asissted personal interviewing (CAPI) integrates data collection, data entry, editing, coding, and cleaning in a single unit. The CAPI is now used widely in face-to-face interviews by university researchers, government agencies, and private-sector survey organizations around the world [1].

In many of the researches, it is demonstrated that computerized surveys have been shown to offer numerous advantages over the traditional paper surveys. For instance in a study made by B. Hanscom, J. D. Lurie, K. Homa, J. N. Weinstein computerized questionnaires and paper questionnaires are compared [13]. They found that the computer surveys had approximately half the missing response rate than the paper surveys. Consistency and completeness of the collected data are also searched thoroughly by Hanscom et.al.. They stated that using computerized questionnaires were more advantageous from these points, too. In another study, two types of field editing used during the Turkey Demographic and Health Survey are compared: computer aided field editing (CAFE) and manual editing [14]. It was demonstrated that there was less missing data and a lower mean number of errors when the CAFÉ was used.

On the other hand, Mobile computer-assisted personal interviewing (MCAPI), with mobile devices, should be seen as the latest stage in this trajectory of computer-assisted methods of survey research. Since, the mobile devices are inexpensive, portable, and energy efficient, they are used as ideal field devices. Using PDAs are cost-effective, since they make it possible to save on paper costs; as well as to bypass

the need for manual data entry. One can also access/send data at anytime to and from anywhere. Mobile devices offer a distinct advantage over laptop computers, because they facilitate a more natural interaction between the interviewer and respondent, and so the interview time becomes shorter.

The graphical interface can be programmed to include various validation rules in order to, for instance, immediately spot and alert the user arising from any problems related with the data collected. This means cross-check can be done at the same time by programming. Thus, in this way it becomes unnecessary to rearrange an interview with another patient in the case of emerging irresolvable conflicting responses, when the data is submitted to the central database [15]. This means that the data become more complete, have fewer errors and are more consistent. Hence, data editing, retyping and clarification processes can be eliminated. Furthermore, logic in the survey can be programmed, and so, irrelevant questions can be eliminated.

2.1.5 Visual Studio .NET

The *.NET platform* is a set of technologies designed to transform the Internet into a full-scale distributed computing platform. The core technologies that make up the .NET platform are [16];

1. *.NET Framework*: The .NET Framework is based on a new common language runtime. This runtime provides a common set of services for

projects built in Visual Studio .NET, regardless of the language (See in Figure 2.2).

2. *.NET Building Block Services*: They are distributed programmable services that are available both online and offline. These services include identity, notification, calendar, directory, search and software delivery.
3. *Visual Studio .NET*: This provides a high-level development environment for building applications on the .NET Framework, major language enhancements, a full access to the .NET Framework, and an enhanced Web development.
4. *.NET Enterprise Servers*: This technology provides scalability, reliability, management and integration within and across organizations.

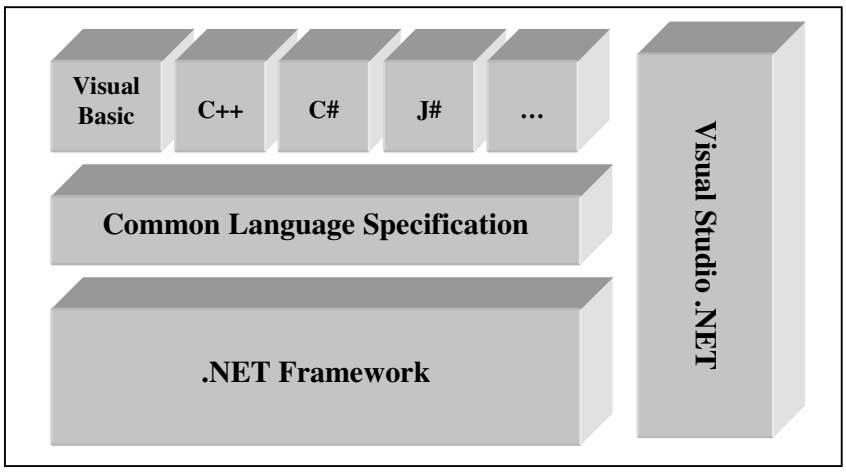

Figure 2.2 Overview of the .NET Framework [16]

Visual Studio .NET

A Visual Studio .NET is an integrated development environment (IDE) for developing web applications, web services, desktop applications, and mobile applications. .NET-compliant languages such as Visual Basic .NET, Visual C++ .NET, and Visual C# .NET employ the same shared IDE, which helps developers to develop their solutions faster. Using the tools in Visual Studio .NET instead of using a command-line compiler makes application development much faster, easier, and more reliable. However, unlike at the command line, one can not create multi-file and multi-language assemblies at Visual Studio .NET.

The benefits of the Visual Studio .NET [17] as an IDE in the development of MQ are;

- While coding, one can access some useful features, such as syntax checking, IntelliSense, context-sensitive help, code-folding, slide-out menus.
- Compilation and debugging are integrated.
- With the help of tools and drag-and-drop controls, application development becomes simpler and easier to maintain and deploy the files to local or remote servers.
- The Toolbox window displays a variety of items such as web and Windows-based form controls, ActiveX controls, XML web services, HTML elements, objects, and items from the Windows Clipboard that can be used in Visual Studio projects.

- By means of Visual Studio .NET mobile Internet features, one can develop applications that target a broad range of web devices, including PDAs, HTML for Pocket PCs and Palm devices.
- Visual Studio .NET makes it easier to view more code onscreen at a time, with features such as auto hide, tabbed documents, and multiple-monitor support.
- The XML Designer provides tools for working with XML and XML Schema Definition (XSD) files.

.NET Compact Framework

With the release of the Visual Studio .NET 2003 a new solution has been introduced for developers who want to start creating applications for mobile devices. It now is possible to develop applications for mobile devices by using Visual Basic and C# .NET. It's a two-part fix that allows one to create applications to run on resource-constrained devices such as the Pocket PC and Windows CE handhelds, in almost the same way as that one would create a regular Windows application.

The first part of the solution is the *.NET Compact Framework*. This is a mini version of the .NET Framework. The .NET Compact Framework runs on the device and includes a large selection of the core Framework classes, including a wide range of controls, plus even stretches for supporting Web services.

The second part of the solution is the ability to create a *smart device application*. This is like a tiny Windows application, with a typical Pocket PC form defaulting to 240 by 320 pixels. The program is built on top of the .NET Compact Framework (which can run on the development machine) and can be packaged into a CAB file and installed directly on ones target device.

2.2 Related Systems and Software

In this section, some MQ systems and software related to our work in terms of idea, technology and implementation are presented. This section is composed of;

- The MQs developed by individuals who started from scratch. These systems are in use or were used for an academic study.
- The MQ software that are user-friendly commercial products used in preparing questionnaires and surveys. These software are in use or were used for different purposes in different places, such as in medical fields, in order to collect information on patients, in an airport for customer satisfaction surveys or for a council to see how their citizens use their services. Some of them are summarized below:

2.2.1 Mobile Nutrition Questionnaire (MNQ)

Selanikio, Kemmer, Bovill, Geisler (2002) developed a handheld computer system, on Palm OS, for administering nutrition questionnaires [18]. This MQ is used to gather nutritional information among the Burmese refugees in the Mae La Refugee Camp on the Thai–Burma border. The study aimed to determine whether the use of handheld-computer-based data collection tools would make the continuing evaluation of this population easier, faster, and more accurate.

Firstly, collaboration between the Center of Excellence in Disaster Management and Humanitarian Assistance, the Centers for Disease Control and Prevention (CDC), the Center for Disaster and Humanitarian Assistance Medicine (CDHAM), University of Washington, the U.S. Army Research Institute of Environmental Medicine (USARIEM), and the Thai Red Cross Society, was realized. Before the study began, some researches had applied the questionnaire, on paper, desktop computer, laptop or PDA. The disadvantages of the paper-based questionnaires in data collection and transferring the data to desktop or laptop computers lead the researchers to seek new solutions. Desktop computers were found to be not quite suitable for field studies but laptop computers. Unfortunately, laptops have also their own requirements, such as a table and a regular power supply. The handheld computers come as a solution to these problems. There are many important advantages of using such devices; a properly constructed electronic questionnaire that can more easily lead a user through a complex series of questions, constraints over the data entered can be made

mandatory on a computerized questionnaire, and there will be no need to clean the data after application.

In the study involving the MNQ some distinct aspects were evaluated:

- *Power requirements*: The two primary factors determining battery life for handhelds are OS (Palm OS, Windows CE) and screen type (monochromatic or colored).
- *Screen legibility*: Although battery life is longer for monochromatic handhelds than for those using colored screens, the backlit colored screens are generally easier to read. In that study, it was aimed to determine if this was true under actual field conditions, and if the monochromatic units, with their longer battery life, were still "legible enough".
- *Impact Resistance*: The handheld computers are simply not durable enough for rugged field use but it can be possible to increase field-worthiness. For this purpose, a very simple product called "Cool Clip" to prevent a fall altogether was planned to be used in that study. It clipped onto the handheld and incorporated a lanyard so that the unit could be worn around the neck
- *Water-Resistance*: Some of the durable cases are water-resistant when they are closed but none of it is water-resistant when opened. In order to overcome these problems water-proof plastic bags were planned for use.
- *Ease of Use*: The concerns about the general ability of using handhelds in the field were taken into consideration. Since the desktops and laptops are prone to crashing and other frustrations people think that handheld devices will be

complex, too. But although handhelds are more complex than clipboards, they are far less complex than PCs.

In the Burmese refugees study [18] five monochromatic-screen Palm IIIxe devices and five colored-screen PalmIIIc devices were used. Furthermore, in order to implement the questionnaire two different development environments (Pendragon Forms and Satellite Forms) were examined, and because of the speed and simplicity advantages, Pendragon Forms were selected.

Before the arrival to Thailand for the study, the questionnaire was entered into the handheld and was reviewed, tested, and modified before the field trial. Training of the team members lasted one day. Since the Thai and Karen team members did not feel themselves confident enough, its use was not required of them, and thus they used the paper questionnaires. So, the data was gathered with both handheld devices and paper-forms.

As a result of that study the MNQ team obtained the following observations:

- The battery life of colored-screen devices was not found to be shorter than that of the monochromatic-screen devices.
- The monochromatic-screens were found to be useful at outdoor but not sufficient for indoor use. For colored-screen devices this situation was reversed.
- The Cool Clip that was planned to be used for impact resistance did not arrive in time for fieldwork, so the use of it could not be evaluated.

- For water resistance the plastic bags were successfully used.
- The use of handheld devices was a success for collecting survey data. The ones that used the handhelds navigated the lengthy survey much more easily than the ones that used the paper-based questionnaire. Questions were answered in order without skipping. The logical branching interpreted correctly without effort of interviewer.
- By the handheld devices the collected data was in high-quality and time for collection to the analysis of data was also reduced.

Besides these positive findings, it was found that some parts must be improved, like the need for having a good user-interface. Some aspects of this technology are ripe for improvement, like easier form development, longer battery life, and more legible screens.

2.2.2 The Best Beginnings Project

The second project related to our work was carried by Bradford with an aim to reduce the numbers of babies born with low birth weights [19]. As a pilot area Riverside & Glyndon and Woolwich Common Sure Start areas were used. In the project a tool was developed to enable quick assessment and identification of women more at risk of having a low birth weight baby. In addition, the information gathered should be conveyed to the project officer quickly and easily.

A questionnaire on a PDA was developed in order to collect the data. The multiple choice questions that were developed by the National Society for the Prevention of Cruelty to Children (NSPCC) were answered by the pregnant women. This questionnaire was designed to identify key factors associated with low birth weight, covering health related problems as well as social and support issues. The midwife asked the questions and built up a profile of the health and social circumstances of the mother-to-be (M2B) by reading each question from, and entering the answers directly into the PDA. The answers were automatically assessed by the PDA and the factors related to low birth weight were determined. The risk levels were also immediately displayed by the tool, like red for high, amber for moderate and green for low risk.

In addition to the displayed results on the device, additional processes continued at the back. Those women identified as requiring high levels of support triggered the PDA to email the M2B Support Officer. This information was accessed via a web browser. The answers that the mother-to-be had given to the questions were then compared with the answers of other high risk pregnant women by the M2B Support Officer. The officers immediately put in place the necessary support services.

The security in the collected information from the questionnaire and M2B Support Workers was also important. The system included carefully designed access levels, safeguards and ‘user profiles’ which controlled and limited access rights to all information.

2.2.3 Mobile Questionnaire on Burn Management

In that study, a questionnaire on Palm OS handheld computers was developed to rapidly assess and treat burn patients with the bedside use of a PDA [20]. Resuscitation and management was predicated on total body surface area (TBSA) burned, and according to this percentage treatment decisions and outcomes were determined.

Application was developed in C for Palm OS handheld computers by using Code Warrior and Visual Build. Colored and grayscale versions of the program are available to allow newer devices to take advantage of high-resolution colored screens while still allowing the older palm devices to be used for the application.

That application is comprised of two sections;

- *Interactive section* includes the questionnaire that is provided along with a Lund and Browder chart. Questions regarding age, weight, time of burn and mechanism of burn, and colors in the Lund and Browder chart with a stylus were answered by the bedside clinician.
- The *searchable mini-textbook* which covers key burn topics including inhalation injury, pediatric burns, topic epidermal necrolysis, frostbite, and local wound care.

After answering the questions, the application provided %TBSA burned, appropriate resuscitation volume, guidelines for treatment, and whether the patient meets

American Burn Association criteria for transfer to a burn center. Also the nearby burn centers with contact numbers were listed if the clinician entered the zip code.

2.2.4 Field Data Collection System (FDCS)

In that study, a customized FDCS [21] had been developed for a handheld computer to collect and check questionnaire data. The aspects that were evaluated in the study are: the data quality, preparation time, and user acceptability of the system. The system was used in a malaria morbidity survey in Bakau, the Gambia.

The data were collected either with the FDCS or on the paper questionnaire forms. Eight workers studied the collected data in the field for a 6-week period. The team observed that significantly fewer item errors occurred with the FDCS. Also when the interview times were compared, it was found that times taken with the FDCS were much less than that of the paper and pencil questionnaire.

As a result, it was stated that advanced appropriate technology may have a useful role in providing accurate and rapid information, particularly in overcoming bottlenecks in data processing, and in obviating the need for costly expertise and equipment. In developing countries this could help to improve the quality of data on health care.

2.2.5 Riptide Survey Software

The application workflow of *Riptide Survey Software* [22] utilizes a simple four step process;

1. The survey is created on the desktop by using a Java-based desktop editor. Firstly survey meta-data is defined including an introduction, objectives and conclusion. Then the questions are generated and then the types for answer are determined as multiple-choice, selected value, open text, date/time or number.
2. Once the survey is completed, it is distributed to a remote device like pocket PC, another desktop computer, laptop or tablet PC (Download to remote devices).
3. Then data is captured using these devices. When the survey runs starting from the introduction, the workflow is followed as defined in the survey template. At the end of the survey the data is saved and uploaded to the survey editor for reporting.
4. The application provides a simple data-reporting tool, but the data can be exported to Microsoft Excel for more advanced reporting.

In this special work, for the mobile devices Microsoft .NET technology was selected because it provides a better performance and quicker development time.

2.2.6 DigSee SURE

The DigSee SURE [23] has been presented by DigSee Ltd. It eliminates paperwork, increases productivity and accesses data faster by using modern emerging technologies such as, mobile computing platforms and wireless data transfer.

The DigSee SURE can be effectively used in market surveys, sociological surveys, merchandising, insurance, manufacturing, mobile staff control, pharmaceutics/healthcare, network marketing and in any other industry. The system can be used on Palm/Pocket PC handhelds or notebooks/Tablet PCs, and practically any communication modes for data synchronization are supported.

The benefits of the system are; being cost saving, distribution of forms are faster, less time on capturing and transferring data, improved data accuracy, getting results fast, efficiency in control of mobile staff activities and efficient work with distributed network of mobile workers regardless of covered area.

The SURE features two components: server and client modules. The server module provides forms creation and distribution capabilities, allowing creation of even sophisticated forms effortlessly. On the other hand, the client module provides the wireless Palm/Pocket PC/Notebook component for faster collection and transfer of data. Together, these components provide a complete solution for mobile data collection.

Main features of the DigSee SURE are:

- To make possible the creation of templates and data input for any forms, reports, and questionnaires.
- To provide convenient tools for data editing and takes advantages of powerful navigating through the form arrays.
- Equipped with means of a syntactical and logical control of forms entry.
- To allow simultaneous inputs by several operators.
- To send the description of any required form or report directly to handhelds of the office and field staff using a cost-effective and compact Palm that easily fits one's shirt pocket.
- To fill in the form or questionnaire and send it wirelessly to the office immediately after or even during discussion with a customer or interview with a respondent.
- To prepare and compile all questionnaire arrays in the office and send them for processing by other software packages, such as MS Excel, MS Access, SPSS or other. It smoothly integrates with existing in-house systems.
- To operate in the unified Microsoft Windows environment.

2.2.7 Snap Survey Software

The Snap software works with PDA surveys in much the same way as it works with paper or online surveys: efficiently and straightforwardly [24]. The Snap has a useful interface and the engine is designed to be adaptable to any method of survey delivery

and collection. To produce a PDA survey is as detailed and simple as the other survey formats. In addition, the Snap is designed to provide users with maximum freedom over how they conduct their surveys which means the same survey can be delivered using both methods.

Firstly the questionnaires are set up by using the standard Snap questionnaire design tool. Then, the questionnaire is simply published and transferred to the PDA using the supplied synchronization cradle. The transfer of the results back for analysis is the same process. In situations where interviewers are working remotely, the published questionnaire can be sent by e-mail, and then loaded locally from PC to PDA using the same simple procedure.

The Snap PDA interviewer has been used in different studies/fields:

- *Birmingham International Airport*; used the Snap PDA interviewer for surveys that range from passenger origin and destination studies to customer satisfaction surveys into the airport's facilities, or surface transportation research.
- *Varga Research*; used the Snap PDA interviewer for face to face field interviews in locations such as hotels, theme parks, restaurants and shopping areas.
- *Wokingham District Council*; used the Snap PDA interviewer for surveys about use and take-up of its many services among the 145,000 citizens that fall within its boundaries.

Users find that the Snap PDA interviewer gives outstanding performance on short, stand up interviews where most questions have predefined answers. It also performs well in lengthy interviews, such as in the home, where it is also feasible to record some free text answers to questions, but the more unstructured the interview becomes, it is correspondingly less practical to use the Snap PDA interviewer. The Snap PDA interviewer is said to give better, more complete and more representative results in a lot less time.

2.2.8 PocketSurvey Software

The PocketSurvey software [25, 26] is an integrated questionnaire survey design and collection software suit. The information is collected by its mobile data collection module, "PocketSurvey Mobile" that is installed on a handheld device. The mobile component of the questionnaire software can run on a variety of mobile devices running Windows CE Version 3.

The survey is designed by the survey design module "PocketSurvey Designer", which works on a Windows PC. For subsequent data analysis and reporting the captured data is transferred from handheld to desktop PC. There is also a handheld simulator built into the PocketSurvey to see how the whole process woks.

This is a user-friendly software that can be used easily by new computer users, too. By using this software;

- Complex asset questionnaires can be created swiftly and efficiently.
- Large and complex questionnaires, such as condition questionnaires, of any size can be created.
- Historical survey results can be reviewed on the handheld.
- Testing can be done by the integrated handheld simulator.

This software can be used in various industry sectors. It can work for property management and asset tracking, stock condition, building inspections and preventive management.

2.2.9 The Entryware System

This is a software product that is designed for MCAPI with Palm OS handheld computers. The Entryware software is a robust tool for face-to-face or self-administered structured interviews in field settings [27].

Different from other software that work on Windows CE platforms, this system works on Palm platform. On the other hand, the Entryware system works well in long questionnaires; it technically allows up to 32,000 questions per questionnaire and 1,295 responses per question.

The Entryware system consists of two applications (Entryware Designer and Entryware Interviewer) for designing questionnaires, transferring data, and

conducting face-to-face interviews with Palm OS handheld computers. This technology offers several key advantages of computer-assisted interviewing in general, especially its true mobility and significantly lower hardware costs draw attention.

The first component of the Entryware is the Entryware Designer program, which is a Windows desktop application for designing questionnaires, transferring data to and from handhelds, and exporting interview data to other desktop applications for analysis. The hardware requirements for this program are minimal: Users need an IBM-compatible Pentium-class PC or better with Windows 95/98/2000/XP or NT 4.0, 20 MB of hard disk space, and 32 MB RAM.

The main window in the Entryware Designer program provides a straightforward, easy-to-use layout with access to the major features of questionnaire design. Questions consist of three elements: the question text, responses, and scripts. The Entryware software supports four response types: open-ended numeric, open-ended text, yes/no, and user-defined lists. The Scripts allow users to display messages, change question routing, and assign or calculate user-defined variables based on any number of conditions.

A very useful feature of the Entryware systems is the ability to specify question and response text in up to fifteen languages for each questionnaire. Another critical feature of this system is the ability to work with multiple interviewers, as there is no limit to the number of handhelds used in a single project. In addition the results

captured from multiple handhelds can be uploaded to a single PC and the data is collected into a single file for processing.

The second component of the Entryware system is the Entryware Interviewer program, a Palm OS application for collecting interview data on handheld computers. The Interviewer software runs on any handheld computer with Palm OS 3.1 or later, and it requires very little RAM. The Interviewer application has a simple, intuitive interface and it is easy to learn.

CHAPTER 3

ASSUMPTIONS, CONSTRAINTS AND DESIGN OF THE MOBILE QUESTIONNAIRE

Detailed information about surveys is given in section 2.1.1. In this work we are interested in data collection phase of a survey. In the following sections, the design of a MQ for the usage of mobile devices in data collection related to health habits and history will be considered. Firstly, the assumptions and constraints for developing and applying a suitable mobile data collection environment will be stated. Then, after giving a brief information about the "Health Habits and History Questionnaire" (HHHQ), we will introduce the design of the MQ, intended in this study.

3.1 Assumptions

The assumptions of our study are;

- The previous stages of the *data collection* phase of a survey (as stated in section 2.2.1) are completed by the researchers engaged in the survey.
- A questionnaire is prepared according to preliminary studies.
- The interviewers are experienced in using PDAs.
- The interviewers are trained about the objective of the study.

- Microsoft ActiveSync program is installed on a PDA and a desktop PC for deployment.
- A call center is setup for the possible problems that may occur during interview.

3.2 Constraints

The constraints of our study are;

- The interviewer should not have a comprehension problem about the questionnaire; the graphical user interface (GUI) should be easy to use.
- PDA has limited display (240 × 320 pixel screen).
- PDA has limited memory (64 MB).
- PDA is battery-powered (Lithium Ion)

3.3 Health Habits and History Questionnaire (HHHQ)

The HHHQ, previously distributed by the NCI [3], is still available from Dr. Gladys Block [28] who is from the University of California at Berkeley.

The purpose of the HHHQ is to facilitate the collection of a minimum core of data which, if gathered in a standard manner, would enhance comparability between studies. The research results, particularly in the area of diet, may find broad

application in the general population. While some of the non-diet data are specific to cancer, it should be noted that the diet questionnaire is not intended to focus only on cancer risk factors, but rather to assess a wide range of dietary risk factors. The intent is to provide a standard format for the collection of a minimum core of data on important, well-established potential confounders and predictive factors [29].

HHHQ asks the respondent a variety of questions about his/her background, environment, and habits, which may affect or be related to his/her health. The information that is collected will help scientists to understand more about the causes of disease (One can see the original form of the questionnaire in Appendix B).

HHHQ takes about 40 minutes to complete [29]. There are questions that can be skipped according to the answer given to the previous question, but as a whole every question should be answered truly and no question should be skipped.

HHHQ has been chosen for the implementation of this study, because;

- It is a widespread questionnaire used in medical studies in foreign countries.
- All types of questions (open-ended, multiple choice, yes-no, etc.) that can be in a questionnaire are contained in it.
- It is a detailed and comprehensive questionnaire and so its application is difficult in paper-based form.
- It is planned to be used in a study in Çukurova Region by the Department of Biostatistics of Çukurova University located in Adana, Turkey.

In this study, our aim is to transform HHHQ into a mobile form in order to be able to apply it in Turkey. In what follows its design is presented.

3.4 Design of the Mobile Questionnaire

The basic aims of the intended program are to improve the quality of data and to reduce the time for data collection and evaluation phase of a survey, as compared to those of the paper-based studies. According to these purposes the functional requirements of the MQ program can be given as follows;

- Interviewer should use keyboard or pen stylus to enter the given answers.
- Entry of data should be eased by using combo boxes, radio buttons or check-boxes.
- At most 2 long and 4 short questions should be displayed in each screen.
- The interviewer should fill in all the questions determined as mandatory.
- Editing quality control process should mostly be eliminated by programmable cross-checks.
- Program should show questions according to the answers of respondent, i.e. questions about cigarettes will be skipped if the respondent does not smoke.
- Program should restrict the answers of some questions by drop-down menus or choice boxes.
- Program should warn the user when the data type of answer does not match with the type determined by the programmer.

- Program should display a confirmation message before finishing the questionnaire.
- Program should store the answers of the respondent in a format that is compatible for analyzing data.
- Program should display a confirmation message before saving the data.

According to these requirements, we have designed and written the MQ program in Visual Basic .NET programming language [30, 31]. Visual Studio .NET is used as an IDE. When the IDE is started, Smart Device Application (SDA) is chosen under Visual Basic programming language. When SDA is selected the framework supporting it is not the .NET Framework, it is the .NET *Compact* Framework. Although one continues to develop the program as a regular Windows application some parts are different, such as certain classes are unavailable or work in an altered fashion. But generally it is similar.

Since the compilation and debugging are integrated in Visual Studio .NET, program has been compiled by Visual Studio .NET and the questionnaire has been deployed on a Pocket PC that runs under Windows CE OS.

The questionnaire application stores the data in an XML file [32] because XML separates the user interface from structured data and allows the seamless integration of distributed applications. Moreover, XML is a text-based format that lets you describe, deliver and exchange structured data. The data stored by using MQ in a

PDA for one day can be uploaded to a desktop PC in the call center by the interviewer at the end of the day.

As a conceptual model the system architecture is shown in Figure 3.1.

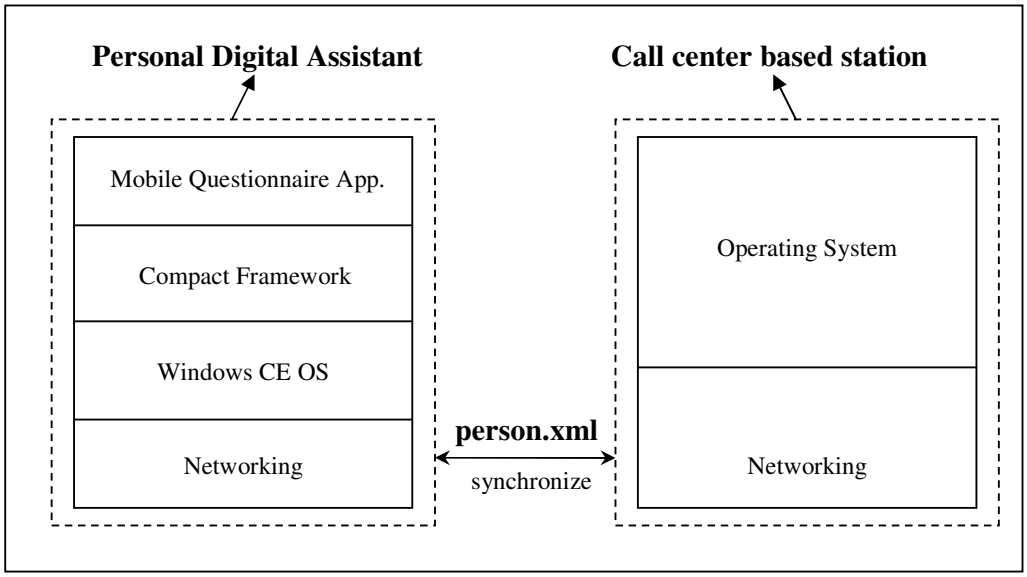

Figure 3.1 System Architecture

The XML file is formed by the "XML Designer" embedded in Visual Studio .NET. The XML files and XSD files can be easily edited by using this designer. The XML schema used in XML document is given in Appendix A. The implementation and testing of the MQ is presented in the following chapter.

CHAPTER 4

IMPLEMENTATION & TESTING OF THE MOBILE QUESTIONNAIRE

The implementation and testing of the application of our MQ are discussed in this chapter.

4.1 Implementation

Whole of the questionnaire is composed of 88 screens, i.e., it can be observed on a total of 88 screens. There are also some message box screens to warn the user about the appropriateness of an entered data or to get the approval from the user to finish the questionnaire or to save the data.

As it will take so many pages to cover all the screens here, some of which are quite smilar, only the main types of screens used in our MQ application are briefly described below.

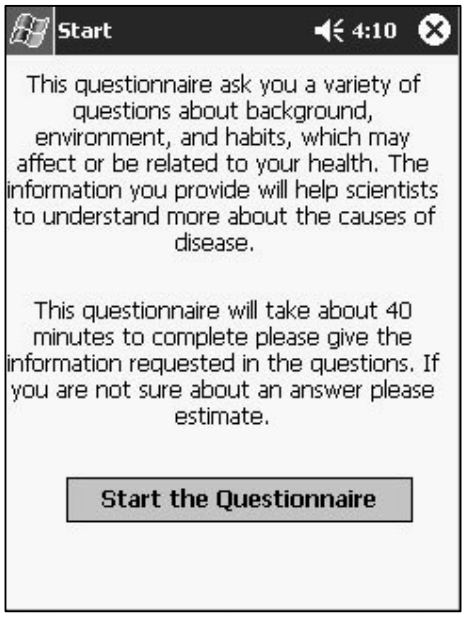

Figure 4.1 Greeting

The screen shown in Figure 4.1 is the greeting screen of the *MQ* application. It gives brief information about the purpose and content of the questionnaire. Also a warning about answering all the questions without skipping is given in this screen. When the user presses the "**Start the Questionnaire**" button the "Introduction" screen will appear.

When the introduction screen is displayed as shown in Figure 4.2, new data can be added by pressing the "**New Person**" button. To exit from the questionnaire the "**Exit**" button should be pressed. The list of the data entered previously is shown in a data-grid tool under these buttons. When the questionnaire finishes new data will be seen in the table. This data-grid is populated with reading from an XML file named ***person.xml***.

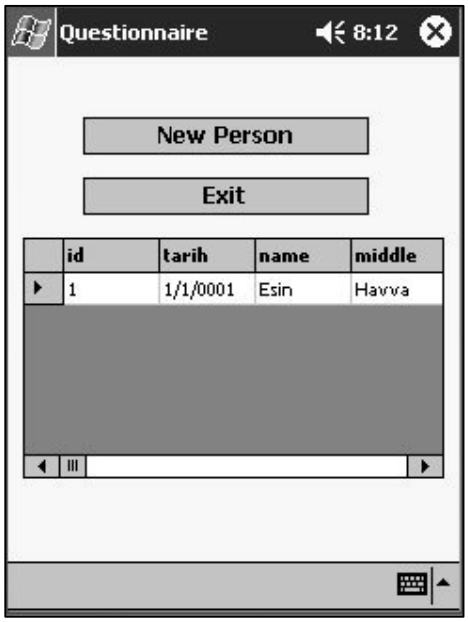

Figure 4.2 Introduction

In the rest of the implementation one will see similar screens as shown in Figure 4.3. These screens show that the user is entering to a new section and give a brief description of the section that will be followed. By stroking the "**Continue**" button one will move to a new section.

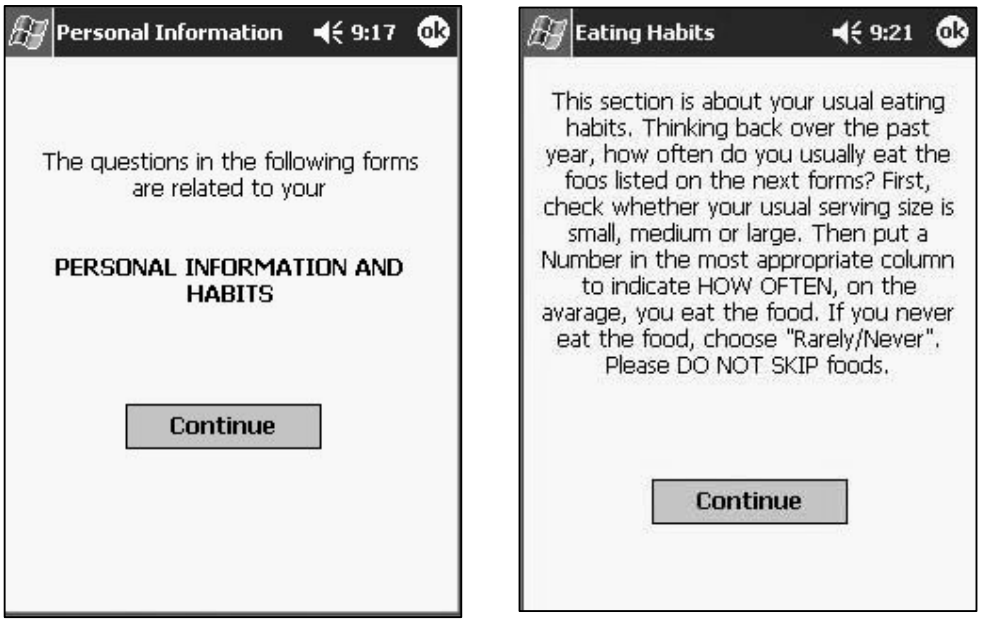

Figure 4.3 Explanation Screens

On the screen in Figure 4.4 the user takes identifier information about the respondent. The textbox fields can be filled by using a pen-like stylus and on-board character recognition software or scaled down keyboard. The choice-group data in combo box can be chosen by a pen stroke. By using "**Next"** and "**Prev**" buttons one can navigate through the next and previous screens, respectively. The use of "**Next" and "Prev"** buttons are the same for all of the screens.

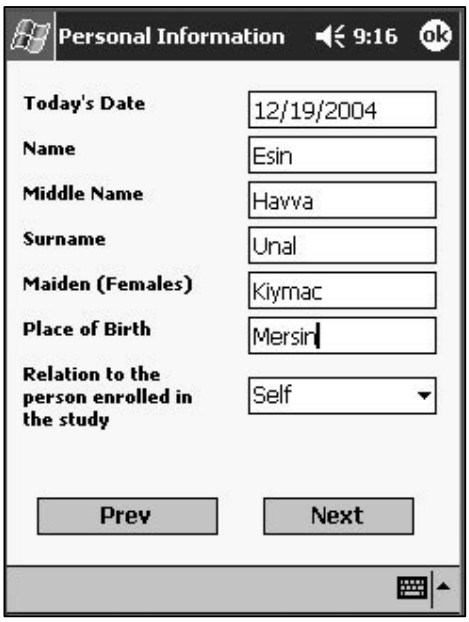

Figure 4.4 Text and Combo Boxes

The screen shot in Figure 4.5 shows certain fields which accept only integer characters, like “Birthday”, “Age” and “Mobility”. When alpha-numeric characters are entered an error message box as shown in Figure 4.6 - I is displayed.

Figure 4.5 Text Box Check - I

If the user sees the first message box in Figure 4.6, it means that the data entered is not in true format (like Integer, Boolean, Date, etc.).The second screen shown in Figure 4.6 is displayed if a field is left as blank.

a **b**

Figure 4.6 Error Message Boxes

a) Warning box for wrongly typed data b) Warning box for missing data

Figure 4.7 shows a screen that involves a single Yes-No question. According to the answer given to this question, the program directs the user to different screens. If the "**Yes**" button is pressed the screen asking more questions about the same topic comes. On the other hand if the user presses "**No**" button, the rest of the questions on this topic will be passed.

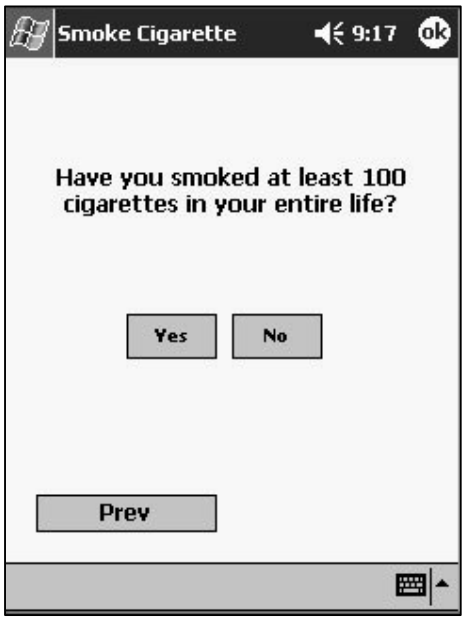

Figure 4.7 Yes-No Type Question - I

Figure 4.8 shows a different type of Yes-No question. This time the user will choose the answer from radio buttons, one at a time. For example, if the user chooses the radio button with the text "**No**" and stroke the "**Next**" button all the questions about taking vitamins and minerals will be passed over and on the screen a different question will be displayed. Contrary, if the user chooses "**Yes, fairly regularly**" or "**Yes, but not regularly**" radio buttons, some more questions on the same topic will be displayed.

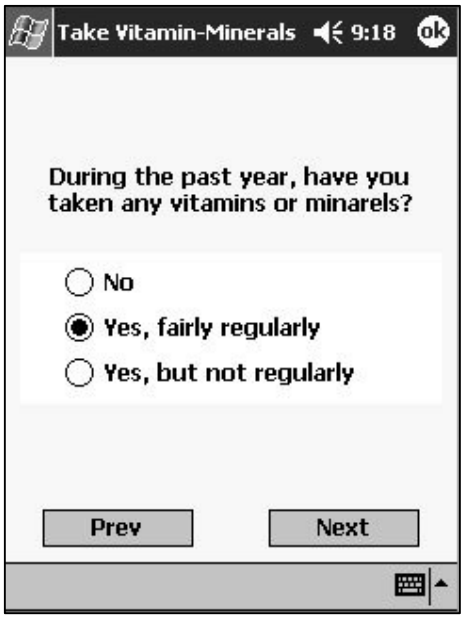

Figure 4.8 Yes-No Type Question - II

Two different questions are displayed on the screen in Figure 4.9. As stated in section 3.4 at most 2 detailed long questions are displayed on one screen. The answers are chosen from drop-down menus.

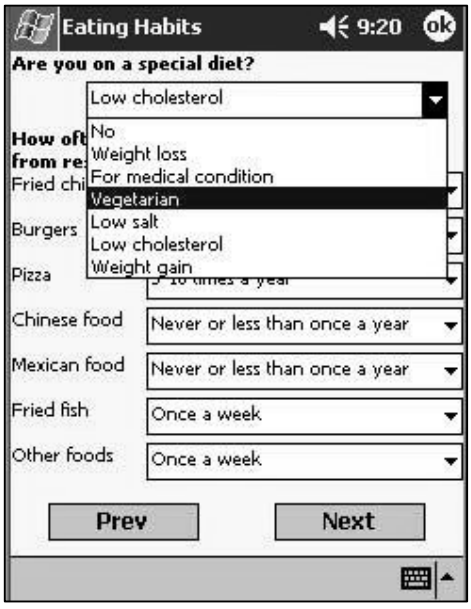

Figure 4.9 Two Questions on One Screen

On the similar screens as shown in Figure 4.10, according to the answer given to a frequency question (Rarely/Never) the amount of food textbox may be left as empty.

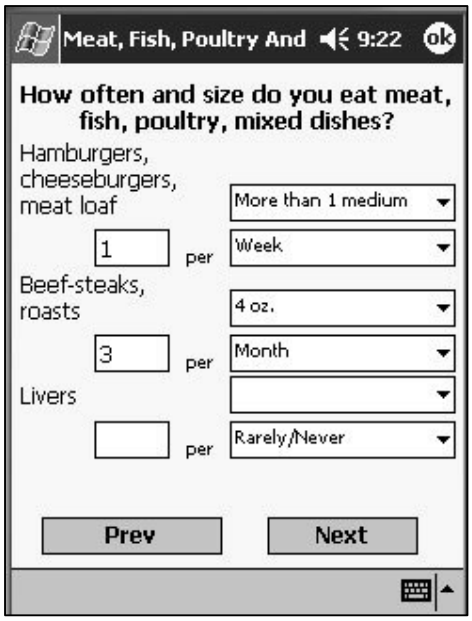

Figure 4.10 Combo Box Check - I

On this screen (Figure 4.11) if the food name field is not filled, the fields related to the food are not written to the xml file.

Figure 4.11 Text Box Check - II

On this screen (Figure 4.12) the user will select an answer from the list. The choices are placed on a panel and so only one answer can be chosen at a time.

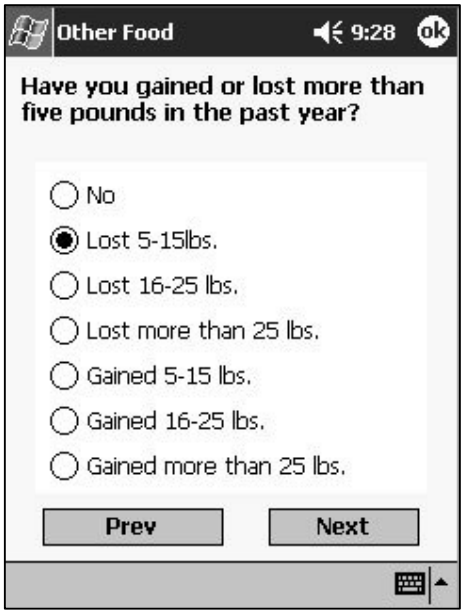

Figure 4.12 Radio Buttons on a Panel

There is a radio button check on the screen shown in Figure 4.13. The answers to the questions "*How many times?*" and "*Age at first treatment*" are written to the XML file if the user chooses the "**Yes**" radio button. Otherwise, these fields are not taken into consideration.

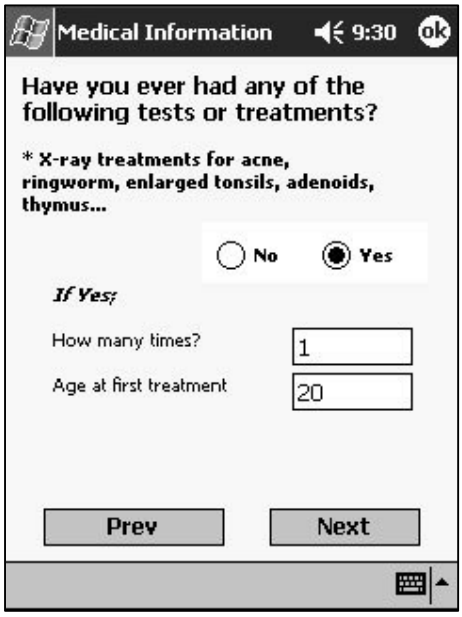

Figure 4.13 Radio Button Check

On this screen (Figure 4.14) "*Yes-No-Don't know*" choices are placed on a panel for each sub-question, so only one of them can be chosen at a time for each sub-question

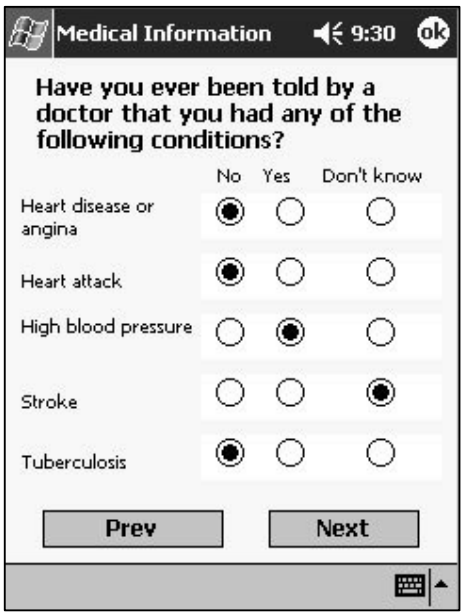

Figure 4.14 Radio Buttons on Multiple Panels

On the screen in Figure 4.15, all types of fields can be seen. These fields are combo box, text box, and radio button.

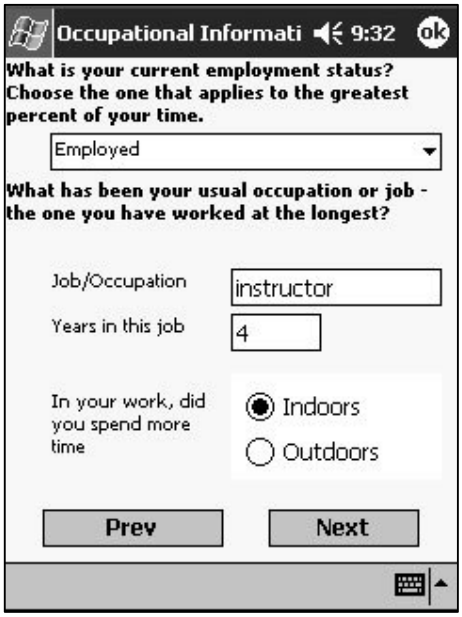

Figure 4.15 All Types of Fields on One Screen

The message box asking to finish the questionnaire is shown in Figure 4.16. If one clicks "**Yes**" button, the questionnaire will be ended and saving process will begin. Otherwise it will go back to the questionnaire.

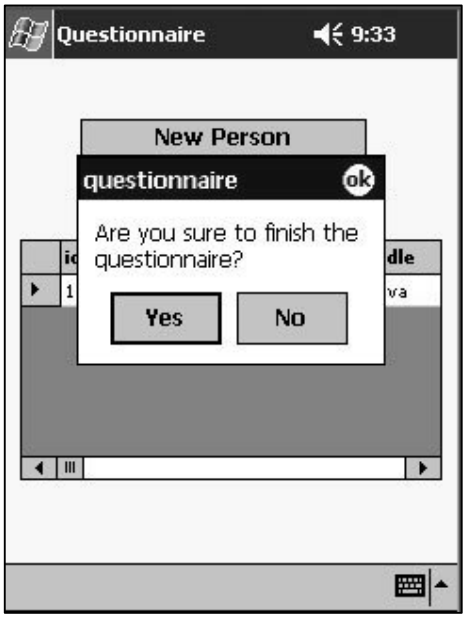

Figure 4.16 Ending Message Box

The message box asking to save the data is shown in Figure 4.17. If one clicks "**Yes**" button, the data will be saved otherwise the process will be cancelled.

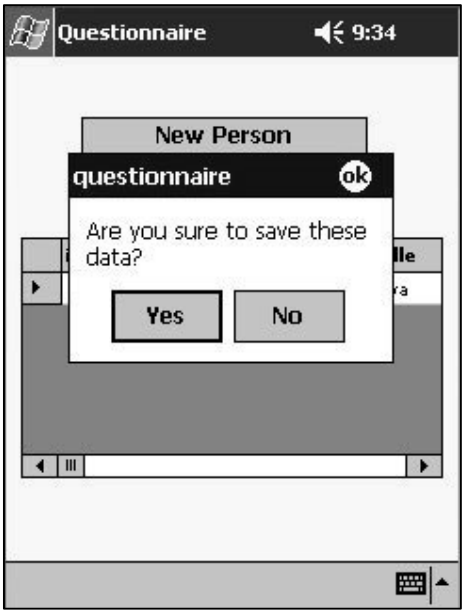

Figure 4.17 Saving Message Box

When the saving process is completed the first screen will be displayed as shown in Figure 4.18. On this screen this time one can see the added data in the data grid. To start the entire scenario again one should click "**New Person**" button. Otherwise, just stroke the stylus on the "**Exit**" button to exit from the questionnaire.

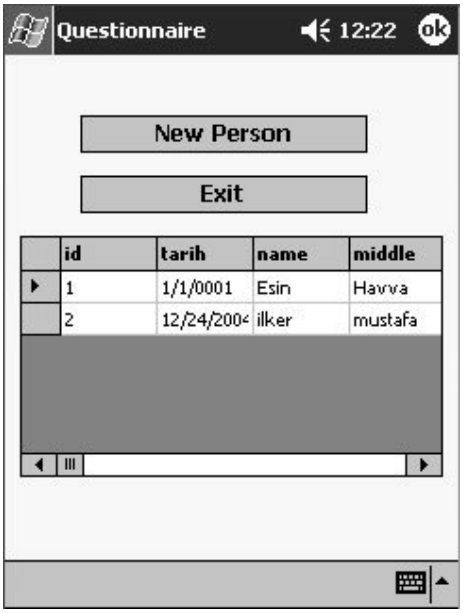

Figure 4.18 Added Data

4.2 Testing

The testing of the "MQ" application is intended in a health survey in Çukurova region by the Department of Biostatistics at the Çukurova University. Unfortunately, because of some financial obstacles this has not been achieved up-to now. However, the project is submitted to the Scientific Research Unit of Çukurova University for

support author as the sub-investigator and passed the first stage of evaluation. If the project is supported, the Turkish version of the program will be tested in an enlarged project with a larger sample.

However, for the time being a mini test of the program has been carried out on 50 people in between December 12, 2004 and February 8, 2005. The paper-based version of the questionnaire is applied to 25 persons and "MQ" is applied to the others. During the tests, the following parameters were evaluated;

- Total time elapsed from the data collection to transferring them into electronic environment.
- Interviewer based errors.
- Reporter based errors.
- Psychological impact.
- Portability, enabling anytime-anywhere implementation

The results of this limited test are as follows;

Time:

The average time of applying questionnaires in the paper-based and MQ methods are 44 minutes and 41 minutes, respectively. From statistical aspect the 3 minute difference can be negligible (p=0,853). The difference in time might be due to the experience of the interviewer in using the PDA or skipping questions according to the answers of the respondents (Answers given to Yes-No type questions).

Furthermore, the time of transferring the collected data into electronic environment takes time. In our case, the entry of a single data in the paper-based method took about 30 to 40 minutes. On the contrary, in the mobile method, the data were transfered to the computer at the end of the day and transfering data of 25 people took less than 1 minute.

In the paper-based method, the effect to time of trying to read bad handwriting has not been tested, because both applying the questionnaire and transferring the data have been done by a single person.

Interviewer and reporter based errors:

In the paper-based form, questionnaire was applied and transferred to the electronic environment by a single person as stated above. Because of this, no problem occurred related to the interviewer and reporter.

Psychological impact:

The respondents that we have applied the paper-based version of HHHQ seemed to be bored of answering a lengthy questionnaire. The others, who were applied the mobile method on the other hand, seemed to be more desired to have the questionnaire. They said that although the questionnaire was long it was not boring because the questions were displayed one by one.

Portability, enabling anytime-anywhere implementation:

During the test both of the methods were applied indoor and outdoor. When the sample size is increased portability problems occured in paper-based method because of the need of carrying rolls of papers from one place to another. On the other hand by using mobile questionnaire we didn't faced any difficulty regarding portability.

Cost Analysis:

The cost of a survey using MQs can be compared with that of a survey using paper-based questionnaires. The total cost of paper-based method can be calculated by taking into account the following items;

- Cost of the questionnaire (ie. photocopy cost)
- Money paid to interviewers
- Cost of controlling quality of questionnaires (ie. money paid to the employees who will control the quality of questionnaires)
- Cost of transferring of the collected data into electronic form (ie. money paid to the employee who makes the transferring process)

On the contrary, the total cost of MQ can be calculated by taking into account the following items;

- Cost of PDAs
- Money paid to interviewers

One will save money if uses MQ method instead of the paper-based method since as seen above quality control and transfer costs will be eliminated in MQ usage.

CHAPTER 5

CONCLUSIONS AND FUTURE WORKS

5.1 Conclusions and Discussions

The "MQ" prepared in this work is really not a survey software in the sense of those described in Sections 2.2.5 to 2.2.9. It is rather a questionnaire prepared for mobile devices. The reason for using the mobile devices is to increase the data quality, and to decrease the cost of survey as well as the turnaround time of studies. For this reason it should be compared with the same type of studies rather than the survey software.

The aim of the "Mobile Nutrition Questionnaire" described in section 2.2.1 was to assess the value of the use of the handheld computers in data collection. That matches with the aim of this thesis. The researchers of that questionnaire before starting their research had decided to evaluate distinct aspects, like power requirements, screen legibility, impact resistance, water resistance and ease of use. In this thesis we are mostly concerned with the ease of using mobile devices in addition

to the objectives given in the previous paragraph. The results of the mentioned study above and our work are compatible in most cases.

In that work navigating in the lengthy survey was easier, no data were lost, and questionnaire was completed correctly when mobile devices were used. Also high-quality data was collected and the time from collection to analysis was significantly reduced. However, they faced some problems with the GUI. But in our mini field study, such problems have not occurred because the places, lengths of the fields and questions have been carefully designed.

In the project described in section 2.2.2, in addition to the data collection, assessment of the data by the PDA was also done. In our case this has not been done because in order to get such results from our data one needs a detailed analysis by the help of a more powerful computer. We have only converted the data to an electronic format (in XML format) which can easily be used in analysis stage.

The MQ application described in section 2.2.3 was composed of two sections, “Interactive” and “Searchable mini textbox” sections. The first part of that study exactly matches with our “MQ” application. The similar advantages of collecting data with a mobile device have been also observed in our case, too.

In the field data collection system described in section 2.2.4, a comparison between the paper-based and mobile-based questionnaires had been done. The results

gathered from that study are similar to our mini test results. They saved time and fewer errors occurred due to the field data collection system.

We developed the MQ instead of using a survey software because there are specific factors that had be taken into consideration while controlling the entered data such as modifiying the questions according to the answer given by the respondent. Also as given in Section 5.2, the program will be incorporated with the Dietsys program [29] so some more modifications and arrangements will be done.

Our "MQ" was tested from December 12, 2004 to February 08, 2005 by the participation of 50 people. The paper-based version of the questionnaire was used for the first 25 and the "MQ" for the others. We have proved that a significant amount of time can be saved when mobile devices are used. We have also found out that the positive psychological impacts of the "MQ" application should not be discarded. It can be said that the MQs give the possibility of anytime-anywhere implementation.

When the cost analysis is done for the paper and mobile based questionnaires it is found that using the PDAs are not only the cheapest but also the most reliable method in a survey. For comparison we have estimated the total cost of applying questionnaires by using PDAs and the paper-based forms. The results indicate the cost advantage of the MQ, apart from its time saving and reliability properties.

Besides these advantages, there may be some disadvantages of using PDAs, such as;

- The OS may crash and the data on it may be lost.
- It may break if it falls and the data on it may be lost.
- During the transfer of data some problems may occur.
- The charge of the PDA should be tracked carefully. A substitute charge may be used in case of lack of charge.

When we compare MQ with the paper-based or desktop-based methods in time, cost and portability advantages, MQ is a more favourable method for such surveys.

5.2 Future Works

For our future work, we are planning to focus on preparing the Turkish version of this program and to apply it in the field study by Department of Biostatistics of the Faculty of Medicine of Çukurova University.

The mini test of the program carried out on the 50 people in the limited conditions is not enough, so some more detailed tests are required before the actual usage. It will be better to test the details of the program on a suitable number of people (sample). Hence, the necessary developments should be done according to the results gathered from the test applied to the sample, before applying it in the Çukurova region.

In our case, the stored data on PDA can be transferred to a desktop computer by a cradle or via a simple cable connection to the computer, or via an infrared-based wireless communication. But for the future work the data exchange can also be done by using the GPRS technology. This technology gives chance to transmit the data immediately, quickly and efficiently, if the radio coverage is enough. By using this technology the turnaround time will decrease significantly and the benefit of the study will be seen in a shorter time.

In addition, the validation of the XML file during the transfer process will be done as a future work. Also the XML schema for XML document used in data storing given in Appendix A will be modified to a more comprehensive structure for future studies.

The data obtained by this study could be incorporated with the Dietsys program [29] which calculates daily vitamin, protein, calorie etc. intake from foods based on HHHQ.

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APPENDICES

APPENDIX A

XML Schema for XML Document Used In Data Storing

```
<?xml version="1.0" ?>
<xs:schema id="kayitlar" targetNamespace="http://tempuri.org/person.xsd"
    xmlns:mstns=http://tempuri.org/person.xsd xmlns="http://tempuri.org/person.xsd"
    xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:msdata="urn:schemas-
    microsoft-com:xml-msdata" attributeFormDefault="qualified"
    elementFormDefault="qualified">
  <xs:element name="kayitlar" msdata:IsDataSet="true" msdata:Locale="tr-TR"
      msdata:EnforceConstraints="False">
    <xs:complexType>
      <xs:choice maxOccurs="unbounded">
          <xs:element name="person">
            <xs:complexType>
              <xs:sequence>
                <xs:element name="id" msdata:AutoIncrement="true"
                msdata:AutoIncrementSeed="1" type="xs:int" minOccurs="0" />
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                <xs:element name="name" type="xs:string" minOccurs="0" />
                <xs:element name="middle" type="xs:string" minOccurs="0" />
                <xs:element name="surname" type="xs:string" minOccurs="0" />
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                <xs:element name="relation" type="xs:string" minOccurs="0" />
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```

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APPENDIX B

The HHHQ that is used in this study compose of 10 pages. The images of these pages are given in the following pages [29].

HEALTH HABITS AND HISTORY QUESTIONNAIRE

This form asks you a variety of questions about your background, environment, and habits, which may affect or be related to your health. The information you provide will help scientists to understand more about the causes of disease.

This questionnaire will take about 40 minutes to complete. Please fill in the information requested, or place a check in the appropriate space. A few questions may be similar to ones you have answered before, but please do not skip any questions for this reason. If you are not sure about an answer, please estimate.

If you have any questions or would like help filling it out, please call ____________________ at _____-_______. Please return this questionnaire by ____________________. We thank you for your time and your contribution to this research.

THIS SPACE FOR OFFICE USE

TODAY'S DATE: Month [ ][ ] - Day [ ][ ] - Year [ ][ ] (11–16)

Please PRINT YOUR NAME (name of study participant)

[ ] LAST (17) [ ] FIRST (31) [ ] MIDDLE (40)

FEMALES: [ ] MAIDEN (49–63)

In what STATE (or country, if not U.S.) were you born? ____________________ 64 __ __ State Code

SOCIAL SECURITY NUMBER: [ ][ ][ ] - [ ][ ] - [ ][ ][ ][ ] (66–74)

This information is completely voluntary. It will be used only to refer to statistical records maintained by the National Center for Health Statistics, in order to determine how health practices may be related to how long people live. For studies conducted by the National Institutes of Health, this information is collected under the authority of section 405(b)(1)(A) of the Public Health Service Act, 42 U.S.C. 284(b)(1)(A).

A __ 79 80

1-10*

ADDRESS: [ ] STREET (11–34)

[ ] CITY (35–49) [ ] STATE [ ] ZIP (52–61) 62 __ __ State Code

TELEPHONE: ([ ][ ][ ]) - [ ][ ][ ] - [ ][ ][ ][ ] (64–73)

What is your relationship to the person enrolled in the study?

1____Self 2____Spouse 3____ Relative 4____Other

__ 74

B __ 79 80

Version 02.1, March, 1987. GEN.ALL.YR.2 -1-

Figure B.5.1 1st Page of HHHQ

THIS PAGE FOR OFFICE USE

PLEASE GO TO NEXT PAGE

Information for coders:

Columns 1–10 are identical on each "card". They are omitted after page 2, but should be repeated on each card.
Col. 80 is blank on each card.
Enter number of the response which was checked (e.g., 1 for male, 2 for female).
For those questions in which a quantity is entered (e.g., years), code as entered.
"9" = Not Stated or Don't know. Leave no blanks. (Blanks are permitted in name and address fields on p. 1, and occupation field on p. 9).
P. 1, Col. 64–65, Col. 62–63: Use state codes shown below.
P. 3, Col. 11–17: Include century of birth: MM DD YYY.
P. 3, Q 10: For each vitamin, code # pills in first two columns; code day, week, etc., in third column (1 = day, 2 = week, 3 = month, 4 = year); code mg/pill in fourth column, using codes shown at bottom of p. 3. If more than one "other vitamin" is checked, code = 8.
P. 5–6: Code as shown on p. 4.
P. 7, Q 14: Code first two columns of each food using codes at bottom of p.7, or additional codes from codebook or database. Code remaining four columns as shown at bottom of p.4.
P. 8, Col. 71–18: No–Yes in 1st column; # times in 2nd col. (8 = 8 or more); age in 3rd–4th col.
P. 8, Col. 46–47, 50–51: Use codes at bottom of p. 8.

State codes:

01 AL Alabama	13 ID Idaho	25 MS Mississippi	37 OK Oklahoma	49 WV West Virginia
02 AK Alaska	14 IL Illinois	26 MO Missouri	38 OR Oregon	50 WI Wisconsin
03 AZ Arizona	15 IN Indiana	27 MT Montana	39 PA Pennsylvania	51 WY Wyoming
04 AR Arkansas	16 IA Iowa	28 NE Nebraska	40 RI Rhode Island	52 PR Puerto Rico
05 CA California	17 KS Kansas	29 NV Nevada	41 SC South Carolina	53 VI Virgin Islands
06 CO Colorado	18 KY Kentucky	30 NH New Hampshire	42 SD South Dakota	54 GU Guam
07 CT Connecticut	19 LA Louisiana	31 NJ New Jersey	43 TN Tennessee	55 Canada
08 DE Delaware	20 ME Maine	32 NM New Mexico	44 TX Texas	56 Cuba
09 DC District of Col.	21 MD Maryland	33 NY New York	45 UT Utah	57 Mexico
10 FL Florida	22 MA Massachusetts	34 NC North Carolina	46 VT Vermont	59 Remainder of World
11 GA Georgia	23 MI Michigan	35 ND North Dakota	47 VA Virginia	99 Unknown or blank
12 HI Hawaii	24 MN Minnesota	36 OH Ohio	48 WA Washington	

Information for proper use of analysis program:

For use with the Personal Computer analysis program, the questionnaire must be keyed in 80-column lines, with the ID field in columns 1–10 of each line, and a line-identifying letter in column 79 of each line, starting with "A" and progressing evenly upward. For use with the mainframe program, the ID and line-ID requirements are less rigid. See Health Habits and History Questionnaire information package for further instructions.

Version 02 of this questionnaire (this version) differs slightly from earlier versions. To use the diet analysis program with this version, you must select the "Nonstandard" option ("STANDQ = N"), and provide the program with the following information, when prompted:

Number of characters = 960

Position of variables:	Card	Col.		Card	Col.		Card	Col.
Name	A	17	Amt. of weight change	J	67	Type of cooking fat	J	54
Age	C	18	First special diet	C	70	Fat on vegetables	J	56
Sex	C	20	Second special diet	C	71	Intake of vitamins	C	43
Height (ft.)	L	43	Whether eats skin	J	47	Intake of multiple vits.	C	44
Height (in.)	L	44	Whether eats fat	J	48	Intake of single vits.	C	53
Weight	L	46	Freq. of cooking fat	J	51	Intake of other vits.	C	69
Weight change	J	68	Unit of cooking fat	J	53	Types of restaurants	C	72

In addition, if you set VEGADJ = Y, tell it J61 when prompted.
In addition, if you set ADDSALT = Y, tell it J49 when prompted.
In addition, if you set COLDCER = Y, tell it J58 when prompted.
In addition, if you set FRTADJ = Y, tell it J64 when prompted.

Number of food fields = 12

Field	Card	Col.	# foods	Field	Card	Col.	# foods	Field	Card	Col.	# foods
1	D	11	15	5	F	11	17	9	G	59	5
2	D	75	1	6	G	11	4	10	H	11	17
3	E	11	12	7	G	31	7	11	I	11	7
4	E	63	4	8	E	59	1	12	I	43	5

All 98 foods included? No
Number not included = 3 Which ones = 6 8 20

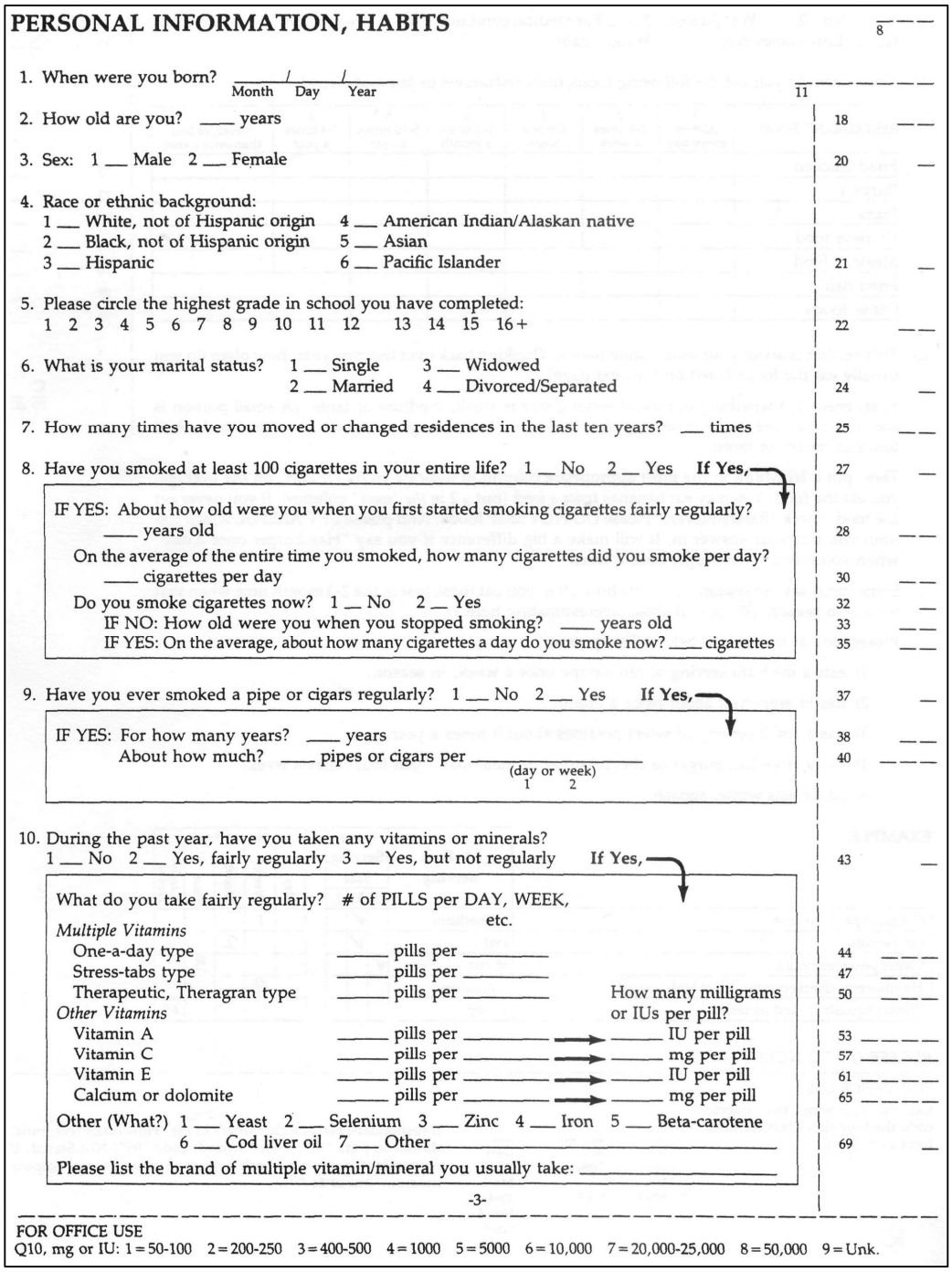
Number of extra foods = 3
1 Food: Card D col. 71 Food code: Card I col. 67
2 Food: Card G col. 27 Food code: Card I col. 69
3 Food: Card I col. 39 Food code: Card I col. 71

Number of open-ended foods = 6 Open-ended information starts in Card J col. 11.

If you modify this questionnaire, you must change the above variables to correspond with your revised version.

-2-

Figure B.5.2 2nd Page of HHHQ



PERSONAL INFORMATION, HABITS

8 ___

1. When were you born? ____/____/____ (Month Day Year) 11 ___ ___ ___ ___ ___ ___

2. How old are you? ____ years 18 ___

3. Sex: 1 ___ Male 2 ___ Female 20 ___

4. Race or ethnic background:
   1 ___ White, not of Hispanic origin
   2 ___ Black, not of Hispanic origin
   3 ___ Hispanic
   4 ___ American Indian/Alaskan native
   5 ___ Asian
   6 ___ Pacific Islander
   21 ___

5. Please circle the highest grade in school you have completed:
   1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16+
   22 ___

6. What is your marital status? 1 ___ Single 2 ___ Married 3 ___ Widowed 4 ___ Divorced/Separated 24 ___

7. How many times have you moved or changed residences in the last ten years? ___ times 25 ___

8. Have you smoked at least 100 cigarettes in your entire life? 1 ___ No 2 ___ Yes **If Yes,** 27 ___

   IF YES: About how old were you when you first started smoking cigarettes fairly regularly?
   ____ years old 28 ___
   On the average of the entire time you smoked, how many cigarettes did you smoke per day?
   ____ cigarettes per day 30 ___
   Do you smoke cigarettes now? 1 ___ No 2 ___ Yes 32 ___
   IF NO: How old were you when you stopped smoking? ____ years old 33 ___
   IF YES: On the average, about how many cigarettes a day do you smoke now? ____ cigarettes 35 ___

9. Have you ever smoked a pipe or cigars regularly? 1 ___ No 2 ___ Yes **If Yes,** 37 ___

   IF YES: For how many years? ____ years 38 ___
   About how much? ____ pipes or cigars per _____ (day or week) 1 2 40 ___ ___ ___

10. During the past year, have you taken any vitamins or minerals?
    1 ___ No 2 ___ Yes, fairly regularly 3 ___ Yes, but not regularly **If Yes,** 43 ___

    What do you take fairly regularly? # of PILLS per DAY, WEEK, etc.

		How many milligrams or IUs per pill?	
Multiple Vitamins			
One-a-day type	____ pills per ____		44 ___ ___ ___
Stress-tabs type	____ pills per ____		47 ___ ___ ___
Therapeutic, Theragran type	____ pills per ____		50 ___ ___ ___
Other Vitamins			
Vitamin A	____ pills per ____ →	____ IU per pill	53 ___ ___ ___ ___
Vitamin C	____ pills per ____ →	____ mg per pill	57 ___ ___ ___ ___
Vitamin E	____ pills per ____ →	____ IU per pill	61 ___ ___ ___ ___
Calcium or dolomite	____ pills per ____ →	____ mg per pill	65 ___ ___ ___ ___

    Other (What?) 1 ___ Yeast 2 ___ Selenium 3 ___ Zinc 4 ___ Iron 5 ___ Beta-carotene
    6 ___ Cod liver oil 7 ___ Other _____ 69 ___

    Please list the brand of multiple vitamin/mineral you usually take: _____

-3-

FOR OFFICE USE
Q10, mg or IU: 1 = 50-100 2 = 200-250 3 = 400-500 4 = 1000 5 = 5000 6 = 10,000 7 = 20,000-25,000 8 = 50,000 9 = Unk.

Figure B.5.3 3rd Page of HHHQ

11. Are you on a special diet?
1 ___ No 2 ___ Weight loss 3 ___ For medical condition 4 ___ Vegetarian 5 ___ Low salt
6 ___ Low cholesterol 7 ___ Weight gain

OFFICE USE
70 ___

12. How often do you eat the following foods from *restaurants* or *fast food places?*

RESTAURANT FOOD	1 Almost every day	2 2-4 times a week	3 Once a week	4 1-3 times a month	5 5-10 times a year	6 1-4 times a year	7 Never, or less than once a year	
Fried chicken								72 ___
Burgers								73 ___
Pizza								74 ___
Chinese food								75 ___
Mexican food								76 ___
Fried fish								77 ___
Other foods								78 ___

13. This section is about your *usual* eating habits. Thinking back over the past year, how often do you usually eat the foods listed on the next page?

C 79 80

First, check (√) whether your usual serving size is small, medium or large. (A small portion is about one-half the medium serving size shown, or less; a large portion is about one-and-a-half times as much, or more.)

Then, put a *NUMBER* in the most appropriate column to indicate *HOW OFTEN*, on the average, you eat the food. You may eat bananas *twice a week* (put a 2 *in the "week"* column). If you never eat the food, check "Rarely/Never." Please DO NOT SKIP foods. And please BE CAREFUL which column you put your answer in. It will make a big difference if you say "Hamburger once a day" when you mean "Hamburger once a week"!

Some items say "in season." Indicate how often you eat these just in the 2-3 month time when that food is in season. (Be careful about overestimating here.)

Please look at the *example* below. This person

1) eats a medium serving of cantaloupe once a week, in season.
2) has ½ grapefruit about twice a month.
3) has a small serving of sweet potatoes about 3 times a year.
4) has a large hamburger or cheeseburger or meat loaf about four times a week.
5) never eats winter squash.

EXAMPLE:

	Medium Serving	Your Serving Size S	M	L	How often? Day	Week	Month	Year	Rarely/ Never
Cantaloupe (in season)	¼ medium		✓			1			
Grapefruit	(½)		✓				2		
Sweet potatoes, yams	½ cup	✓						3	
Hamburger, cheeseburger, meat loaf	1 medium					4			
Winter squash, baked squash	½ cup								✓

PLEASE GO TO NEXT PAGE -4-

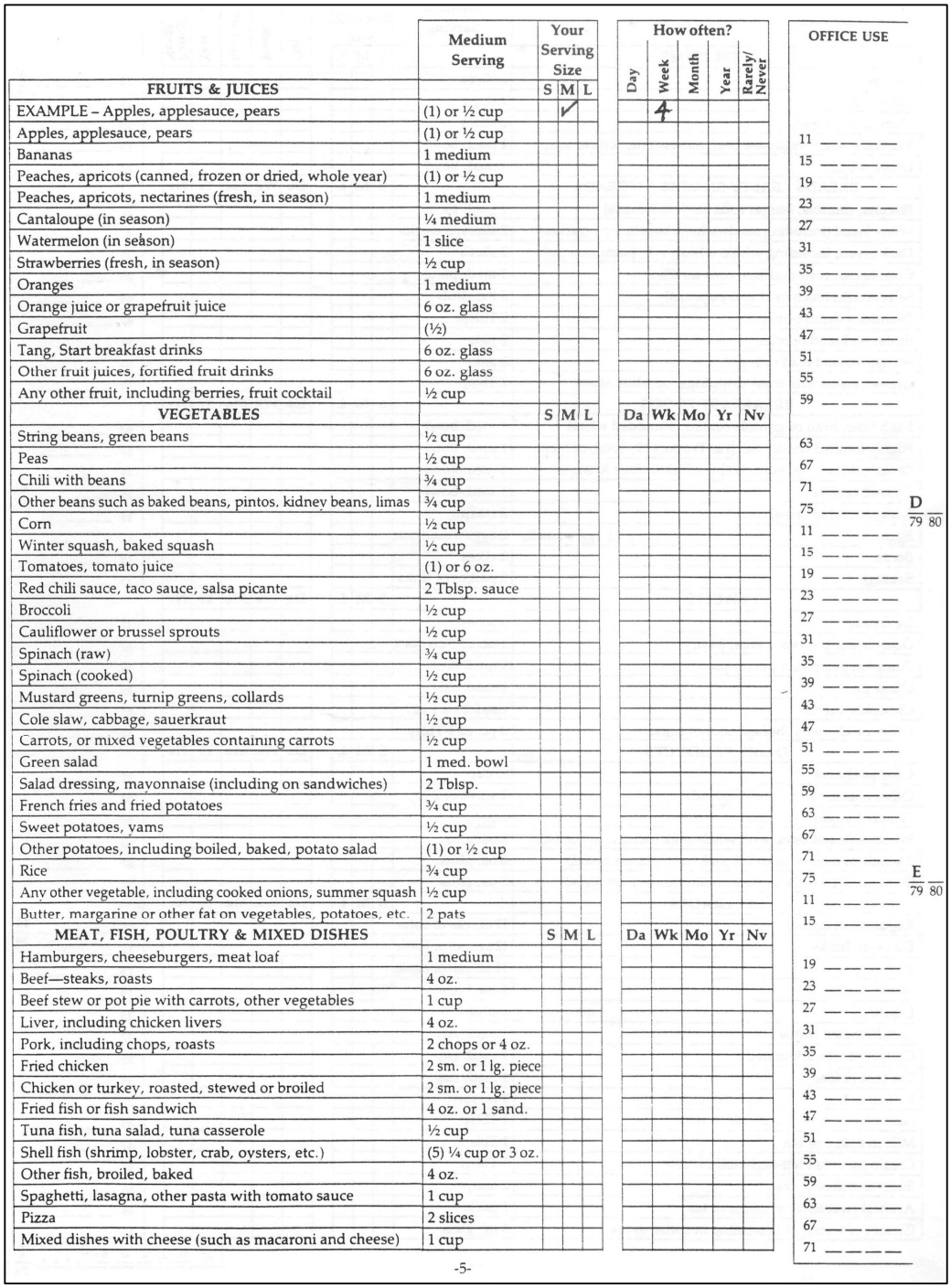
FOR OFFICE USE

On the following two pages, code the four characters for each food as follows:

___	___ ___	___
S-1	No.	Da-1
M-2	Times	Wk-2
L-3		Mo-3
NS-9	NS-99	Yr-4
		Nev-5
		NS-9

If respondent places a checkmark in the "How often" columns, **do not** impute "01", once. Instead, code "99", Not Stated. If respondent does not check a portion size, **do not** impute medium, but code "9".

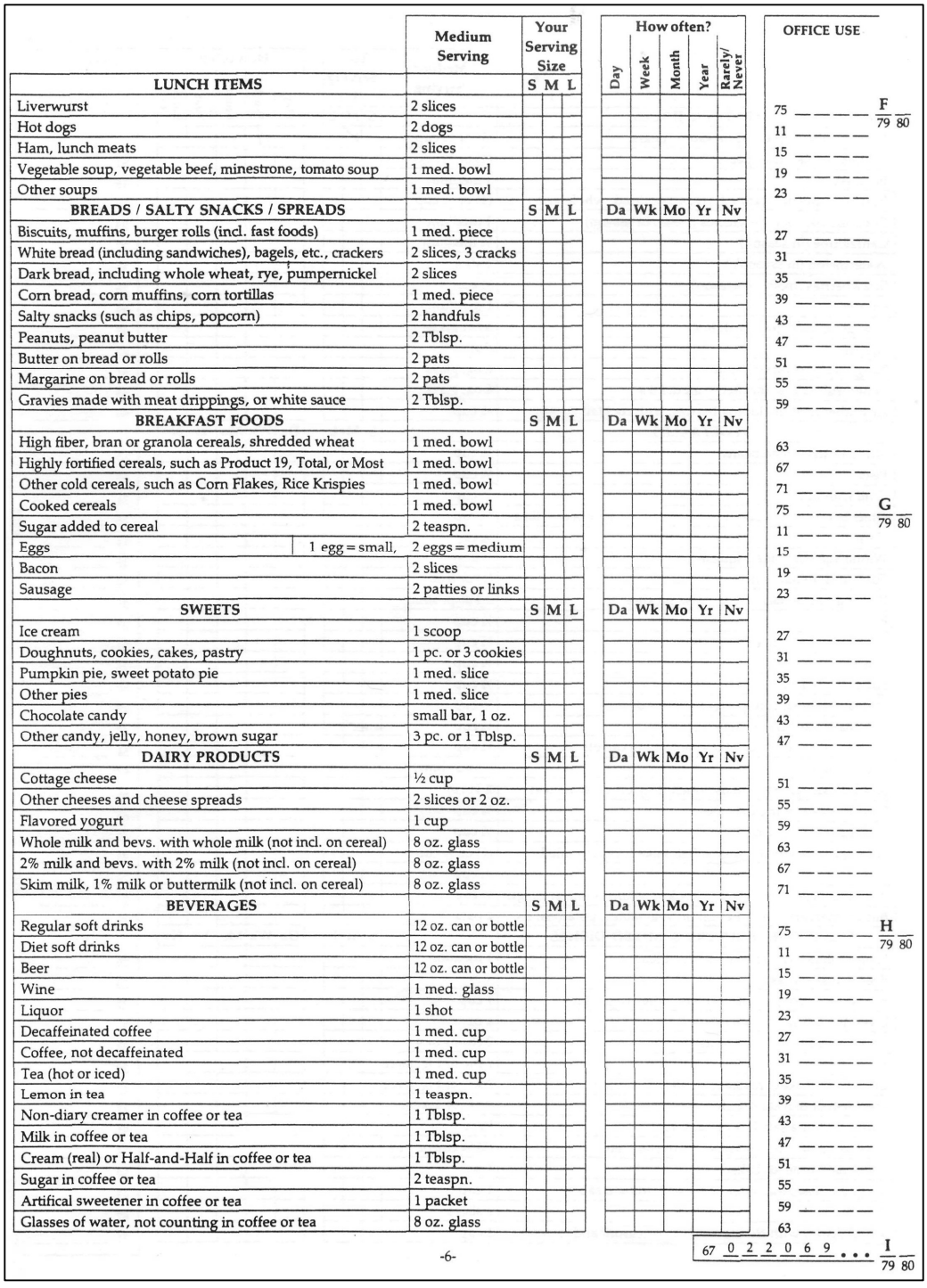
Figure B.5.4 4th Page of HHHQ



	Medium Serving	Your Serving Size			How often?					OFFICE USE
					Day	Week	Month	Year	Rarely/ Never	
FRUITS & JUICES		S	M	L						
EXAMPLE – Apples, applesauce, pears	(1) or ½ cup		✓			4				
Apples, applesauce, pears	(1) or ½ cup									11 ___ ___ ___ ___
Bananas	1 medium									15 ___ ___ ___ ___
Peaches, apricots (canned, frozen or dried, whole year)	(1) or ½ cup									19 ___ ___ ___ ___
Peaches, apricots, nectarines (fresh, in season)	1 medium									23 ___ ___ ___ ___
Cantaloupe (in season)	¼ medium									27 ___ ___ ___ ___
Watermelon (in season)	1 slice									31 ___ ___ ___ ___
Strawberries (fresh, in season)	½ cup									35 ___ ___ ___ ___
Oranges	1 medium									39 ___ ___ ___ ___
Orange juice or grapefruit juice	6 oz. glass									43 ___ ___ ___ ___
Grapefruit	(½)									47 ___ ___ ___ ___
Tang, Start breakfast drinks	6 oz. glass									51 ___ ___ ___ ___
Other fruit juices, fortified fruit drinks	6 oz. glass									55 ___ ___ ___ ___
Any other fruit, including berries, fruit cocktail	½ cup									59 ___ ___ ___ ___
VEGETABLES		S	M	L	Da	Wk	Mo	Yr	Nv	
String beans, green beans	½ cup									63 ___ ___ ___ ___
Peas	½ cup									67 ___ ___ ___ ___
Chili with beans	¾ cup									71 ___ ___ ___ ___
Other beans such as baked beans, pintos, kidney beans, limas	¾ cup									75 ___ ___ ___ ___ D 79 80
Corn	½ cup									11 ___ ___ ___ ___
Winter squash, baked squash	½ cup									15 ___ ___ ___ ___
Tomatoes, tomato juice	(1) or 6 oz.									19 ___ ___ ___ ___
Red chili sauce, taco sauce, salsa picante	2 Tblsp. sauce									23 ___ ___ ___ ___
Broccoli	½ cup									27 ___ ___ ___ ___
Cauliflower or brussel sprouts	½ cup									31 ___ ___ ___ ___
Spinach (raw)	¾ cup									35 ___ ___ ___ ___
Spinach (cooked)	½ cup									39 ___ ___ ___ ___
Mustard greens, turnip greens, collards	½ cup									43 ___ ___ ___ ___
Cole slaw, cabbage, sauerkraut	½ cup									47 ___ ___ ___ ___
Carrots, or mixed vegetables containing carrots	½ cup									51 ___ ___ ___ ___
Green salad	1 med. bowl									55 ___ ___ ___ ___
Salad dressing, mayonnaise (including on sandwiches)	2 Tblsp.									59 ___ ___ ___ ___
French fries and fried potatoes	¾ cup									63 ___ ___ ___ ___
Sweet potatoes, yams	½ cup									67 ___ ___ ___ ___
Other potatoes, including boiled, baked, potato salad	(1) or ½ cup									71 ___ ___ ___ ___
Rice	¾ cup									75 ___ ___ ___ ___ E 79 80
Any other vegetable, including cooked onions, summer squash	½ cup									11 ___ ___ ___ ___
Butter, margarine or other fat on vegetables, potatoes, etc.	2 pats									15 ___ ___ ___ ___
MEAT, FISH, POULTRY & MIXED DISHES		S	M	L	Da	Wk	Mo	Yr	Nv	
Hamburgers, cheeseburgers, meat loaf	1 medium									19 ___ ___ ___ ___
Beef—steaks, roasts	4 oz.									23 ___ ___ ___ ___
Beef stew or pot pie with carrots, other vegetables	1 cup									27 ___ ___ ___ ___
Liver, including chicken livers	4 oz.									31 ___ ___ ___ ___
Pork, including chops, roasts	2 chops or 4 oz.									35 ___ ___ ___ ___
Fried chicken	2 sm. or 1 lg. piece									39 ___ ___ ___ ___
Chicken or turkey, roasted, stewed or broiled	2 sm. or 1 lg. piece									43 ___ ___ ___ ___
Fried fish or fish sandwich	4 oz. or 1 sand.									47 ___ ___ ___ ___
Tuna fish, tuna salad, tuna casserole	½ cup									51 ___ ___ ___ ___
Shell fish (shrimp, lobster, crab, oysters, etc.)	(5) ¼ cup or 3 oz.									55 ___ ___ ___ ___
Other fish, broiled, baked	4 oz.									59 ___ ___ ___ ___
Spaghetti, lasagna, other pasta with tomato sauce	1 cup									63 ___ ___ ___ ___
Pizza	2 slices									67 ___ ___ ___ ___
Mixed dishes with cheese (such as macaroni and cheese)	1 cup									71 ___ ___ ___ ___

-5-

Figure B.5.5 5th Page of HHHQ



	Medium Serving	Your Serving Size			How often?					OFFICE USE
					Day	Week	Month	Year	Rarely/ Never	
LUNCH ITEMS		S	M	L						
Liverwurst	2 slices									75 F
Hot dogs	2 dogs									11
Ham, lunch meats	2 slices									15
Vegetable soup, vegetable beef, minestrone, tomato soup	1 med. bowl									19
Other soups	1 med. bowl									23
BREADS / SALTY SNACKS / SPREADS		S	M	L	Da	Wk	Mo	Yr	Nv	
Biscuits, muffins, burger rolls (incl. fast foods)	1 med. piece									27
White bread (including sandwiches), bagels, etc., crackers	2 slices, 3 cracks									31
Dark bread, including whole wheat, rye, pumpernickel	2 slices									35
Corn bread, corn muffins, corn tortillas	1 med. piece									39
Salty snacks (such as chips, popcorn)	2 handfuls									43
Peanuts, peanut butter	2 Tblsp.									47
Butter on bread or rolls	2 pats									51
Margarine on bread or rolls	2 pats									55
Gravies made with meat drippings, or white sauce	2 Tblsp.									59
BREAKFAST FOODS		S	M	L	Da	Wk	Mo	Yr	Nv	
High fiber, bran or granola cereals, shredded wheat	1 med. bowl									63
Highly fortified cereals, such as Product 19, Total, or Most	1 med. bowl									67
Other cold cereals, such as Corn Flakes, Rice Krispies	1 med. bowl									71
Cooked cereals	1 med. bowl									75 G
Sugar added to cereal	2 teaspn.									11
Eggs (1 egg = small, 2 eggs = medium)										15
Bacon	2 slices									19
Sausage	2 patties or links									23
SWEETS		S	M	L	Da	Wk	Mo	Yr	Nv	
Ice cream	1 scoop									27
Doughnuts, cookies, cakes, pastry	1 pc. or 3 cookies									31
Pumpkin pie, sweet potato pie	1 med. slice									35
Other pies	1 med. slice									39
Chocolate candy	small bar, 1 oz.									43
Other candy, jelly, honey, brown sugar	3 pc. or 1 Tblsp.									47
DAIRY PRODUCTS		S	M	L	Da	Wk	Mo	Yr	Nv	
Cottage cheese	½ cup									51
Other cheeses and cheese spreads	2 slices or 2 oz.									55
Flavored yogurt	1 cup									59
Whole milk and bevs. with whole milk (not incl. on cereal)	8 oz. glass									63
2% milk and bevs. with 2% milk (not incl. on cereal)	8 oz. glass									67
Skim milk, 1% milk or buttermilk (not incl. on cereal)	8 oz. glass									71
BEVERAGES		S	M	L	Da	Wk	Mo	Yr	Nv	
Regular soft drinks	12 oz. can or bottle									75 H
Diet soft drinks	12 oz. can or bottle									11
Beer	12 oz. can or bottle									15
Wine	1 med. glass									19
Liquor	1 shot									23
Decaffeinated coffee	1 med. cup									27
Coffee, not decaffeinated	1 med. cup									31
Tea (hot or iced)	1 med. cup									35
Lemon in tea	1 teaspn.									39
Non-diary creamer in coffee or tea	1 Tblsp.									43
Milk in coffee or tea	1 Tblsp.									47
Cream (real) or Half-and-Half in coffee or tea	1 Tblsp.									51
Sugar in coffee or tea	2 teaspn.									55
Artifical sweetener in coffee or tea	1 packet									59
Glasses of water, not counting in coffee or tea	8 oz. glass									63

67 0 2 2 0 6 9 . . . I

Figure B.5.6 6th Page of HHHQ

14. Think about your diet over the last year and the responses you have just made on this questionnaire. Are there any foods not mentioned which you ate *at least once a week*, even in small quantities, or ate frequently in a particular season? Consider other meats, breakfast foods, catsup, green chilies or jalapenos, avocado (guacamole), Mexican dishes, Chinese or other ethnic foods, other fruits or vegetables, as well as nutritional supplements (bran, etc.). *Please take a look at the list of foods at the bottom of the page.*

FOOD	Your Serving Size			How Often?		OFFICE USE Code	Amounts
	S	M	L	Day	Week		
						11	
						17	
						23	
						29	
						35	
						41	

	1 Seldom/Never	2 Sometimes	3 Often/Always		
15. How often do you eat the skin on chicken?				47	
How often do you eat the fat on meat?				48	
How often do you add salt to your food?				49	
How often do you add pepper to your food?				50	

16. How often do you use fat or oil in cooking?
For example, in frying eggs, meat or vegetables? _____ times per _____ (day, week, month) — 51

17. What do you *usually* cook with? 1 ___ Don't know or don't cook 2 ___ Soft margarine
3 ___ Stick margarine 4 ___ Butter 5 ___ Oil 6 ___ Lard, fatback, bacon fat
7 ___ Pam or no oil — 54

18. What kind of fat do you *usually* add to vegetables, potatoes, etc?
1 ___ Don't add fat 2 ___ Soft margarine 3 ___ Stick margarine 4 ___ Butter
5 ___ Half butter, half margarine 6 ___ Lard, fatback, bacon fat — 56

19. If you eat cold cereal, what kind do you eat most often? _____ — 58

20. Not counting salad or potatoes, about how many vegetables do you eat per day or per week? _____ vegetables per _____ day, week — 61

21. Not counting juices, how many fruits do you usually eat per day or per week? _____ fruits per _____ day, week — 64

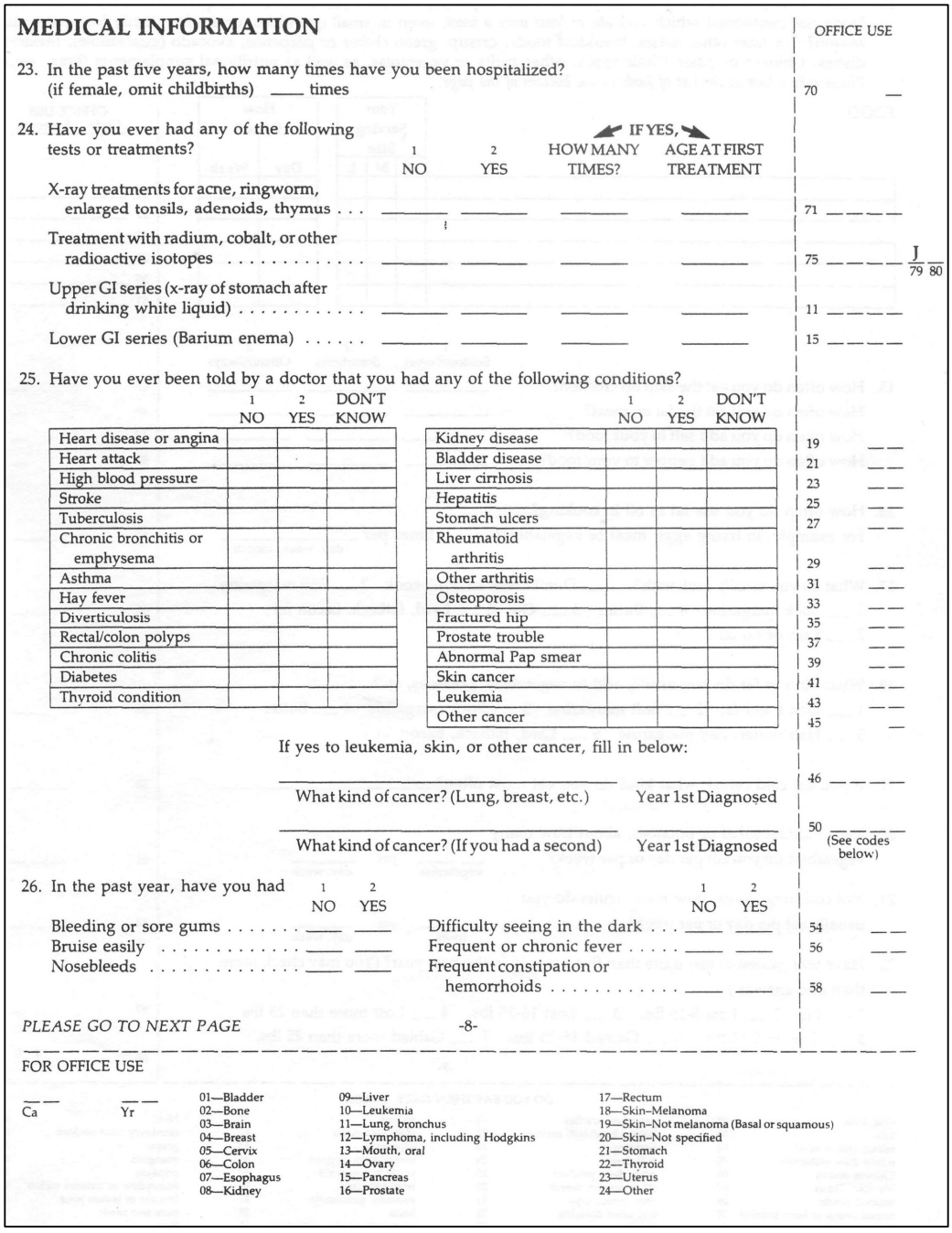
22. Have you gained or lost more than five pounds in the past year? (You may check more than one answer.)
1 ___ No 2 ___ Lost 5-15 lbs. 3 ___ Lost 16-25 lbs. 4 ___ Lost more than 25 lbs. — 67
5 ___ Gained 5-15 lbs. 6 ___ Gained 16-25 lbs. 7 ___ Gained more than 25 lbs.

-7- — 68 99

DO YOU EAT THESE ONCE A WEEK?

veal, lamb	01	pancakes, waffles	21	onions	41	Hi-C	63
tofu	03	instant breakfast, metrecal	22	summer squash	42	cranberry juice cocktail	64
mixed dish w/meat	04	pudding	23	asparagus	43	grapes	65
mixed dish w/chicken	05	milkshake	24	sweet green peppers	44	mangoes	66
Chinese dishes	06	other diary product	25	sweet red peppers	45	papayas	67
Mexican dishes	07	other dessert, sweet	26	bean sprouts	46	honeydew or cassaba melon	68
seafood creole	08	sour cream, dips	31	avocado, guacamole	47	lemons or lemon juice	69
refried beans or bean burritos	09	diet salad dressing	32	beets	48	nuts and seeds	70
Polish or Italian sausage	10	catsup	33	pineapple or pineapple juice	61	bran	71
cream soups	11	green chilies, jalapenos	34	prunes or prune juice	62	other vegetable/fruit	79
noodles	12					other not mentioned here	88

Figure B.5.7 7th Page of HHHQ



MEDICAL INFORMATION

OFFICE USE

23. In the past five years, how many times have you been hospitalized? (if female, omit childbirths) ____ times — 70 __

24. Have you ever had any of the following tests or treatments?

	1 NO	2 YES	IF YES, HOW MANY TIMES?	IF YES, AGE AT FIRST TREATMENT	
X-ray treatments for acne, ringworm, enlarged tonsils, adenoids, thymus					71
Treatment with radium, cobalt, or other radioactive isotopes					75 J 79 80
Upper GI series (x-ray of stomach after drinking white liquid)					11
Lower GI series (Barium enema)					15

25. Have you ever been told by a doctor that you had any of the following conditions?

	1 NO	2 YES	DON'T KNOW		1 NO	2 YES	DON'T KNOW	
Heart disease or angina				Kidney disease				19
Heart attack				Bladder disease				21
High blood pressure				Liver cirrhosis				23
Stroke				Hepatitis				25
Tuberculosis				Stomach ulcers				27
Chronic bronchitis or emphysema				Rheumatoid arthritis				29
Asthma				Other arthritis				31
Hay fever				Osteoporosis				33
Diverticulosis				Fractured hip				35
Rectal/colon polyps				Prostate trouble				37
Chronic colitis				Abnormal Pap smear				39
Diabetes				Skin cancer				41
Thyroid condition				Leukemia				43
				Other cancer				45

If yes to leukemia, skin, or other cancer, fill in below:

_____ _____ — 46

What kind of cancer? (Lung, breast, etc.) Year 1st Diagnosed

_____ _____ — 50

What kind of cancer? (If you had a second) Year 1st Diagnosed (See codes below)

26. In the past year, have you had

	1 NO	2 YES		1 NO	2 YES	
Bleeding or sore gums	____	____	Difficulty seeing in the dark	____	____	54
Bruise easily	____	____	Frequent or chronic fever	____	____	56
Nosebleeds	____	____	Frequent constipation or hemorrhoids	____	____	58

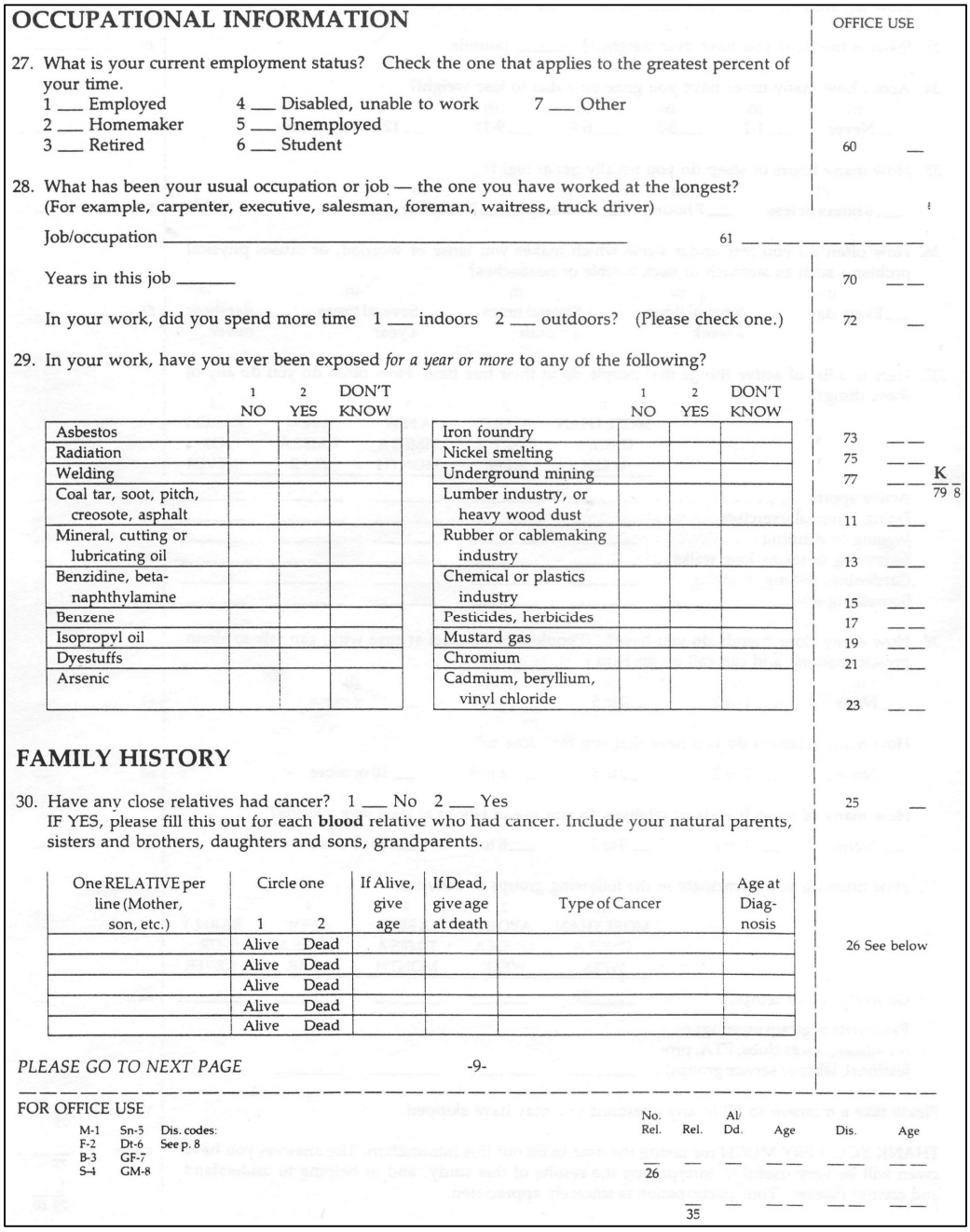
PLEASE GO TO NEXT PAGE -8-

FOR OFFICE USE

Ca __ Yr __

01—Bladder
02—Bone
03—Brain
04—Breast
05—Cervix
06—Colon
07—Esophagus
08—Kidney
09—Liver
10—Leukemia
11—Lung, bronchus
12—Lymphoma, including Hodgkins
13—Mouth, oral
14—Ovary
15—Pancreas
16—Prostate
17—Rectum
18—Skin–Melanoma
19—Skin–Not melanoma (Basal or squamous)
20—Skin–Not specified
21—Stomach
22—Thyroid
23—Uterus
24—Other

Figure B.5.8 8th Page of HHHQ



OCCUPATIONAL INFORMATION

OFFICE USE

27. What is your current employment status? Check the one that applies to the greatest percent of your time.
    1 ___ Employed 4 ___ Disabled, unable to work 7 ___ Other
    2 ___ Homemaker 5 ___ Unemployed
    3 ___ Retired 6 ___ Student

60 ___

28. What has been your usual occupation or job — the one you have worked at the longest? (For example, carpenter, executive, salesman, foreman, waitress, truck driver)

Job/occupation _____ 61 _____

Years in this job _____ 70 ___

In your work, did you spend more time 1 ___ indoors 2 ___ outdoors? (Please check one.) 72 ___

29. In your work, have you ever been exposed *for a year or more* to any of the following?

	1 NO	2 YES	DON'T KNOW	
Asbestos				73 ___
Radiation				75 ___
Welding				77 ___ K
Coal tar, soot, pitch, creosote, asphalt				79 8
Mineral, cutting or lubricating oil				11 ___
Benzidine, beta-naphthylamine				13 ___
Benzene				15 ___
Isopropyl oil				17 ___
Dyestuffs				19 ___
Arsenic				21 ___

	1 NO	2 YES	DON'T KNOW	
Iron foundry				
Nickel smelting				
Underground mining				
Lumber industry, or heavy wood dust				
Rubber or cablemaking industry				
Chemical or plastics industry				
Pesticides, herbicides				
Mustard gas				
Chromium				
Cadmium, beryllium, vinyl chloride				23 ___

FAMILY HISTORY

30. Have any close relatives had cancer? 1 ___ No 2 ___ Yes 25 ___
    IF YES, please fill this out for each **blood** relative who had cancer. Include your natural parents, sisters and brothers, daughters and sons, grandparents.

One RELATIVE per line (Mother, son, etc.)	Circle one 1	2	If Alive, give age	If Dead, give age at death	Type of Cancer	Age at Diagnosis
	Alive	Dead				
	Alive	Dead				
	Alive	Dead				
	Alive	Dead				
	Alive	Dead				

26 See below

PLEASE GO TO NEXT PAGE -9-

FOR OFFICE USE

M-1 Sn-5 Dis. codes: See p. 8
F-2 Dt-6
B-3 GF-7
S-4 GM-8

No. Rel.	Rel.	Al/ Dd.	Age	Dis.	Age
26	___	___	___	___	___
35	___	___	___	___	___

Figure B.5.9 9th Page of HHHQ

OTHER HEALTH FACTORS

OFFICE USE

31. How tall are you? ____ feet ____ inches 32. How much do you weigh? _____ pounds — — — — — — 43

33. What is the most you have ever weighed? _____ pounds 49 — — —

34. About how many times have you gone on a diet to lose weight?

(1) ___Never (2) ___1-2 (3) ___3-5 (4) ___6-8 (5) ___9-11 (6) ___12 or more times 52 —

35. How many hours of sleep do you usually get at night?

(1) ___6 hours or less (2) ___7 hours (3) ___8 hours (4) ___9 hours or more 53 —

36. How often do you feel under stress which makes you tense or worried, or causes physical problems such as stomach or back trouble or headaches?

(1) ___Every day (2) ___Several times a week (3) ___Several times a month (4) ___Several times a year (5) ___Rarely or never 54 —

37. Here is a list of active things that people do in their free time. How often do you do any of these things?

	1 MORE THAN ONCE A WEEK	2 ABOUT ONCE A WEEK	3 A FEW TIMES A MONTH	4 A FEW TIMES A YEAR	5 RARELY OR NEVER		
Active sports	_____	_____	_____	_____	_____	55	—
Doing physical exercises	_____	_____	_____	_____	_____	56	—
Jogging or running	_____	_____	_____	_____	_____	57	—
Swimming or taking long walks .	_____	_____	_____	_____	_____	58	—
Gardening, fishing, hunting . . .	_____	_____	_____	_____	_____	59	—
Something else_____ . .	_____	_____	_____	_____	_____	60	—

38. How many close friends do you have? (People that you feel at ease with, can talk to about private matters, and can call on for help.)

(1) ___None (2) ___1 or 2 (3) ___3 to 5 (4) ___6 to 9 (5) ___10 or more 61 —

How many relatives do you have that you feel close to?

___None ___1 or 2 ___3 to 5 ___6 to 9 ___10 or more 62 —

How many of these friends or relatives do you see or talk to at least *once a month*?

___None ___1 or 2 ___3 to 5 ___6 to 9 ___10 or more 63 —

39. How often do you participate in the following groups or activities?

	1 MORE THAN ONCE A WEEK	2 ABOUT ONCE A WEEK	3 A FEW TIMES A MONTH	4 A FEW TIMES A YEAR	5 RARELY OR NEVER		
Go to church or temple	_____	_____	_____	_____	_____	64	—
Participate in group meetings or activities (such as clubs, PTA, professional, labor or service groups) .	_____	_____	_____	_____	_____	65	—

Please take a moment to fill in any questions you may have skipped.

Version # 0 2 / 75 —

THANK YOU VERY MUCH for taking the time to fill out this information. The answers you have given will be very useful in interpreting the results of this study, and in helping to understand and control disease. Your participation is sincerely appreciated.

Coder: — — / 77

L / 79 80

Reviewed by _____

Figure B.5.10 10th Page of HHHQ