Better health data with a portable microcomputer at the periphery: an anthropometric survey in Cape Verde

P. REITMAIER,¹ A. DUPRET,² & W. A. M. CUTTING³

A portable microcomputer was programmed to record anthropometric nutritional data from children aged under 7 years in either a clinic or a population survey situation. An alarm sounds when the anthropometric measurements of a child are below a predetermined value; an immediate check thus avoids the need for subsequent data cleaning and discarding of doubtful information. Data cut-off points in the computer can be adjusted to suit the survey or service needs of the situation. A print-out at the end of the clinic session provides immediate feedback for the staff and a record of the nutritional status of the group.

In Cape Verde, 14 670 children attending clinics were surveyed; 26% were identified as stunted, 3% as wasted, and 1% as stunted and wasted. While a portable microcomputer can improve precision, speed and motivation, nutrition surveys still depend on accurate scales, careful measurements and competent staff.

Planned improvements in health care services depend on surveillance, i.e., the regular and systematic collection of health-related information. The routine organization of such data is very necessary for their practical application. As long ago as 1839 William Farr, the founder of health statistics, considered vital data and observed that "in order that these materials should be available for such beneficial purposes, it was obvious that they should be duly arranged" (2). Today the microcomputer can efficiently perform the necessary calculations and tabulations to present these data.

Problems occur in health surveillance and data collection, even in countries with a structured health system and legal requirements to report births, deaths and notifiable diseases. In some developing countries, surveys of disease and health services are difficult to carry out, but the results are essential for the effective use of limited resources.

DATA COLLECTION AT THE PERIPHERY OF HEALTH SERVICES

Some countries expect their understaffed health services to provide regular reports on the utilization of facilities, e.g., numbers of patients, diagnoses, deaths, and immunizations given. Often data collection is incomplete or inaccurate because it is a perfunctory and monotonous chore which is rarely acknowledged and the results are often not utilized when decisions have to be made about patient management or service planning.

Anthropometric data on children may contain errors due to inaccurate age estimates or mistakes in measurement and recording. If calculations are involved, as when working out weight-for-height ratios, further errors are possible. "Cleaning up" such data is laborious and time-consuming and inevitably results in the rejection of uncorrectable results. Sometimes there is a delay of years between a survey and the publication of the results so that it is point-

¹ Assistant Professor, Institute of Tropical Hygiene and Public Health, University of Heidelberg, Heidelberg, Federal Republic of Germany.
² Director, Maternal and Child Health Services, Ministry of Health, Labour and Social Affairs, Praia, Cape Verde.
³ Senior Lecturer, Department of Child Life and Health, University of Edinburgh, Edinburgh EH9 1UW, Scotland. Requests for reprints should be sent to this author.
less to base operational decisions on them. The use of a portable microcomputer is promising because it eliminates these drawbacks.

EQUIPMENT AND METHOD

The aim of the new approach is to collect more accurately, and collate more promptly, health data about populations during surveys, and ultimately in the health services. As an example of how the method and equipment can be used, the anthropometric measurements of children in Cape Verde, off West Africa, were collected at maternal and child health (MCH) clinics. A pocket computer, model Sharp PC1500A, was specially programmed to collect, calculate and store information about the ages, weights, heights, and the breast-feeding and immunization status of all children attending the MCH services. The computers are battery operated and weigh only 400 g.

The function of the computer is increased by a RAM-extension (Sharp CE161) and a four-colour plotter (CE150). A simple cassette recorder (CE152) serves for external mass storage. The whole outfit weighs only 2 kg making it readily transportable. One computer (used by P.R.) worked effectively for 3 years, including carriage by motorcycle and backpack without any failures. The four-colour plotter formats diagrams, tables and lists which can be printed at the end of a clinic or working session and shared immediately with the local staff and the

Fig. 1. The Sharp PC1600 pocket computer with printer.
families concerned. The latest model of the computer (PC1600) utilizes a single unit for storage on disc drive and printer (Fig. 1.).

The software for the nutritional surveys has been prepared for both computers, each with two separate programmes, one to process data from child clinic or outpatient services, the other from properly selected samples from any community. The results presented here are from clinics for children. A separate paper will give details about the computing and programming aspects of the methodology. The following section describes how anthropometric measurements were processed and used in the Cape Verde clinics.

On arrival at the clinic, the child's sex and date of birth (only those below 84 months old) are first keyed into the computer. As soon as the child has been weighed and measured, the weight and height are also entered into the computer. The anthropometric status of the child is indicated on the display. If the status shown looks unlikely to the worker doing the survey, the age, weight and height can be immediately checked to see if the data entered were correct. If any of the indices (weight-for-age, weight-for-height, or height-for-age) for the individual child is outside a predetermined level, an audible alarm sounds. This is also a signal to check again the age, weight, and height to see whether any of the data were incorrect. If these are confirmed and the child's growth status is still outside the normal range, the confirmed information is then stored in the memory.

The alarm signal is also a reminder that a child whose measurements are outside the normal range deserves preliminary investigation with at least a history and physical examination to try and detect the cause of the poor satisfactory growth. Counselling for the parents and family will usually follow, and the child's name can be written in a register of those attending the clinic who are at high risk and need to be followed up (1).

Other information, e.g., the number of immunizations a child has had, can be keyed into the computer. If a further dose or other immunizations are indicated at this age and date, the computer's alarm could be made to sound again and the requirements will be displayed. This method is not proposed for routine service data collection at this stage, but to improve the accuracy in periodic special surveys.

Table 1. Nutrition classification of groups of children (Waterlow/WHO)

<table>
<thead>
<tr>
<th>Weight-for-height</th>
<th>Height-for-age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Stunted</td>
<td>&quot;Normal&quot; nutrition</td>
</tr>
<tr>
<td>-2SD</td>
<td></td>
</tr>
<tr>
<td>Stunted and wasted</td>
<td>Wasted</td>
</tr>
<tr>
<td>-2 SD</td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

The classification of malnutrition used for the computer program is a slight extension of the Waterlow/WHO method (7). The classification of children uses weight-for-height (to measure wasting) and height-for-age (to measure stunting) (Table 1.). This strict definition, using -2SD of weight-for-height as the cut-off point, classifies few children as wasted, but a considerable number of those who are stunted are also thin on clinical examination. In the operational situation these thin and stunted children need to be identified for appropriate intervention, and so an additional group was included in the computer program for the classification of Cape Verde children. Children who were between -1SD and -2SD below the mean for weight-for-height (slightly wasted), and were also less than -2SD for height-for-age (stunted) were described as "mildly wasted and stunted" to distinguish them from those in the classical categories of malnutrition (Table 2). In the Cape Verde clinics

Table 2. Extended nutrition classification for groups of children

<table>
<thead>
<tr>
<th>Weight-for-height</th>
<th>Height-for-age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Stunted (17%)</td>
<td>&quot;Normal&quot; nutrition (72%)</td>
</tr>
<tr>
<td>-1SD</td>
<td></td>
</tr>
<tr>
<td>Mildly wasted and stunted (8%)</td>
<td>Wasted (3%)</td>
</tr>
<tr>
<td>-2 SD</td>
<td></td>
</tr>
<tr>
<td>Wasted and stunted (1%)</td>
<td></td>
</tr>
</tbody>
</table>

*Percentages in parentheses in each category indicate the results of the study of 14,570 children aged 1-6 years in clinics in Cape Verde.
this classification has practical usefulness, by increasing the proportion of children for special surveillance from about 3% to 11%. One advantage of the computer is that it can be programmed to provide a cut-off point at any level, a flexibility that can be adjusted to practical action in different circumstances (see footnote b).

The proportion of children whose measurements are below a certain threshold can be printed out. Those with a weight-for-age less than −2SD are considered as underweight. This is different from the weight-for-age classification originally used by Gomez et al. (3). Using the means and SDs is a more satisfactory way to look at the nutritional status of children in a community than percentages below arbitrary cut-off points. The results for groups of children are calculated and printed out as either tables (Fig. 2, top) or diagrams indicating the means by age group, with their significance (Fig. 2, bottom). The percentages below the cut-off points are also summarized in Table 2.

In Fig. 2 (top), the sex and age groups by years are shown separately. In each box relating to a nutritional parameter, the mean and standard deviation of the frequency distribution of the SD score for the group is at the top. Below, in small figures is the number of children in the group (N). At the bottom of the box is the percentage of the children under −2SD of the mean, or another threshold in the SD score, for the age group. At the foot of each age column is a box which contains four small figures which are a summary of the types and percentages of malnourished children of that age. The bottom left figure is the percentage who are both stunted and wasted; above it is the percentage who are simply wasted. The top right figure is the percentage who are "mildly wasted and stunted", and below it is the sum (rounded up or down) of all the three percentages, which gives an indication of the proportion of children in the age group who could benefit from some investigation and possible intervention.

A summary of the means of the various nutritional parameters by age and sex is shown as a series of vertical bars (Fig. 2, bottom). The parallel lines at the centre of each bar indicate the mean for the group, and can be compared with the +1SD, zero, −1SD and −2SD horizontal lines. The thickness of the parallel lines is an indication of the significance, by t-test, between the mean for the group and the standard. Thin parallel lines indicate no statistical significance, while thick lines imply \( P < 0.01 \) and those of intermediate thickness indicate \( P < 0.05 \).

The data on 16 670 children attending the Cape Verde MCH clinics are shown in the tables compiled by the computer and then printed out (Fig. 2, top). Only the totals are shown here, and the nutritional state of the children is not discussed in detail since it is the data collection and compilation technique which is the main issue. The height or length of children under 12 months of age was not measured in the clinics, and therefore only the weight-for-age index is shown for the two halves of the first year. In the first six months the mean weight-for-age of the infants was positive, but by the second six months, the mean was almost −1SD, and became worse in subsequent years. The standard weight-for-height, the indicator of wasting, was depressed (but not severely) from 1 to 6 years of age; the height-for-age mean was consistently depressed at about −1.4SD, showing that there was considerable stunting at all ages. There appears to be more stunting and wasting in boys than in girls over 4 years of age. A total of about 11% of the Cape Verde children under 7 years of age had a nutritional status which justified health intervention.

**DISCUSSION**

Computers are gradually being introduced into decision-making in various aspects of medical care (5), and a hand-held computer has been shown to reduce unnecessary admissions to coronary care units in the USA (4). We have made use of such an instrument to process health information about individuals and groups of children in a rural Third World situation where, according to some views, there is no place for advanced technology until basic needs are met. Our experience indicates that these needs may be more effectively served by the appropriate and sensitive application of such tools.

During the anthropometric survey, any measurement of a child which was less than the predetermined cut-off point causes an audible alarm to sound, so that the input data could be checked immediately. Errors due to a wrong measurement or date of birth or a fault in entering the information can be reviewed and corrected at once while the mother and child are still present. This immediate "plausibility check" eliminates the need for the stage known as "data cleaning", which is usually performed later in the process when it is impossible to verify most factors. "Cleaning" then amounts to the removal of unexplainable information and data sets that may contain the most severely abnormal children.

The automatic calculation of nutritional status by the computer reduces a further source of error. The structure of a computer program standardizes the methodology and the results are more reliable between different observers and in surveys at different times and places. In addition, the ease with which a computer can be commanded to use different cut-off points permits a flexibility that can be adjusted to the population needs and the service requirements. The method can be used in clinics to conduct surveys
Fig. 2. Tables of anthropometric nutritional parameters of Cape Verde children shown as means of standard deviations by age group for females (F), males (M) and both (T), as presented in strips by the computer printer. The means and standard deviations (SD) of anthropometric data are presented graphically (see text).
without disrupting the routine work. By use of standardization, realistic comparisons over a period of time and between different services are possible. The surveys in Cape Verde were conducted economically and efficiently by personnel with very limited education.

Accuracy of data collection can be improved by making this rather monotonous chore more interesting. The computer with its instantaneous response and audiovisual signals does this. The possibility of printing out the results of the measurements at the end of a session and immediately sharing them with the local population and health workers adds an important dimension to the work of the data collector, since he immediately becomes a communicator of significant health-related information, not merely a clerk noting lists of numbers. This was certainly appreciated by the field workers in Cape Verde. If, in addition, it is possible to institute prompt action, it provides not only job satisfaction for the collector, but credibility to the process of surveillance.

No amount of computer skill and programming, however, can overcome errors in anthropometric measurements. Sound staff training, checking of scales, and careful attention to detail are more important than any method of data processing. When used sensitively and intelligently with an appropriate program, a pocket computer can increase the accuracy and speed of data collection, and the motivation of staff concerned with health and nutritional surveillance, as was achieved in Cape Verde.

ACKNOWLEDGEMENTS

We are grateful for the help and encouragement of the Ministry of Health, Labour and Social Affairs, Cape Verde, the medical officers and staff including Dr. I. de Carvalho and Dr. E. Rocha, as well as Professor J. H. Diesfeld and colleagues at the Institute of Tropical Hygiene and Public Health, Heidelberg, Federal Republic of Germany.

RÉSUMÉ

DE MEILLEURES DONNÉES SANITAIRES GRÂCE À UN MICRO-ORDINATEUR PORTATIF: L’EXEMPLE D’UNE ENQUÊTE ANTHROPOMÉTRIQUE AU CAP-VERD

On peut orienter les stratégies de soins de santé primaires avec le maximum d’efficacité si l’on dispose de données de surveillance permettant de repérer les problèmes rapidement et de définir les priorités en matière d’intervention. Le micro-ordinateur est un outil précieux pour les enquêtes ou la surveillance, même dans le cadre de services de santé simplifiés, car il améliore la précision et la vitesse d’exécution et renforce les motivations du personnel. Notre expérience de l’utilisation d’un micro-ordinateur portatif pour enregistrer les données anthropométriques relatives à l’état nutritionnel d’enfants du Cap-Vert en est l’illustration.

On a programmé un micro-ordinateur Sharp PC1500A pour qu’il calcule, garde en mémoire et classe les données concernant l’âge, le poids et la taille d’enfants âgés de 0 à 84 mois examinés dans les dispensaires de santé maternelle et infantile, ou lors d’enquêtes anthropométriques dans la population. Dès que les données concernant un enfant ont été introduites dans l’ordinateur, son état anthropométrique est affiché et si l’un des indices est en dehors des limites prédéterminées, un avertisseur sonore se déclenche et l’agent de santé peut immédiatement vérifier les mesures et les données. Cet avertisseur doit être réglé de façon à indiquer les niveaux de sous-nutrition “dangereux”; en cas de déclenchement, on peut procéder à un examen plus poussé de l’enfant si les circonstances le justifient et donner des conseils appropriés à la famille. Les données peuvent être enregistrées sur cassette ou sur disquette. A la sortie du dispensaire ou à la fin de l’enquête, un traceur portatif fournit des tableaux et des figures illustrant l’état nutritionnel des enfants, éléments qui sont immédiatement montrés au personnel ou aux familles, ce qui permet de discuter des problèmes qui se posent et de donner des conseils pour corriger la situation.

Cette approche a été testée au Cap-Vert dans une enquête portant sur 14 670 enfants examinés dans des dispensaires. En fixant la limite à 2 écart-types par rapport aux normes du NCHS pour les rapports poids/taille et taille/âge, on a constaté 3% de cas d’émaciation, 1% de cas d’émaciation accompagnée d’un retard de croissance, et 26% de cas de retard de croissance.

Au nombre des avantages de ce système on peut mentionner l’avertisseur sonore indiquant la nécessité d’une étude nutritionnelle et d’une éventuelle intervention, la vérification immédiate des mesures dans tous les cas douteux, et le fait de ne pas avoir à “épurer” les données par la suite pour éliminer les mesures aberrantes. Le calcul automatique des indices nutritionnels évite aussi les erreurs. Enfin, la rétroaction immédiate sur le personnel de santé et sur les familles montre l’importance de ces enquêtes, favorise la coopération et permet une plus grande rapidité d’action. Toutefois, les résultats dépendent toujours de l’exacité des balances, du soin apporté aux mesures, ainsi que de la compétence et de la motivation du personnel.
REFERENCES


Just published

Rational Use of Diagnostic Imaging in Paediatrics

A technical report that promises to stimulate major changes in routine imaging practice

This book presents straightforward, precise and highly detailed advice concerning the correct and safe use of diagnostic imaging techniques in paediatric patients, including neonates. Both conventional imaging techniques and a range of new procedures are considered in detail. The objective is to make readers conscious of the many clinical and technical questions surrounding specific techniques and specific indications and then to answer these questions as clearly and authoritatively as possible. Recommended do's and don'ts, which represent the consensus reached by 17 international experts, are backed by reference to well over 500 published reports. Throughout the book, emphasis is placed on the urgent and universal need to eliminate unnecessary and potentially dangerous examinations, many of which have become part of routine practice.

The main part of the book consists of chapters covering diagnostic techniques and indications for each of four body regions: the chest, the extremities, the abdomen, and the skull and spine. For each body region, readers are introduced to all imaging techniques, whether conventional or new, common or rarely used, that might be relevant to diagnostic decisions and procedures in that body region. Techniques are succinctly characterized in terms of their advantages, limitations, potential to yield accurate diagnostic information, proper application, effectiveness compared with other techniques, associated risks to children or neonates, and common technical or diagnostic errors.

Each chapter then lists all relevant indications, specific to the body region, where different imaging techniques might be considered a diagnostic aid. In view of the dangers of radiation exposure in this age group as well as cost considerations, these sections make a special effort to give paediatricians, physicians, and radiologists reliable advice concerning which films should be taken, which clinical examinations are more helpful, and which imaging practices should be discouraged as yielding neither useful, reliable, nor exclusive diagnostic information. The book concludes with an outline of general measures that can result in substantial reductions in unnecessary exposure. Ten measures that can be implemented in any X-ray department are followed by an additional eight measures relevant to departments where special-purpose equipment is available for paediatric radiology.

Concise and to the point, the book presents technical information and arguments of sufficient strength to encourage major changes in routine imaging practice, underscoring the clear advantages of these techniques in well-defined cases while also pointing out the many other cases where clinical examinations provide the best, the safest, and the most cost-effective diagnostic information in paediatric patients.

Rational Use of Diagnostic Imaging in Paediatrics
Report of a WHO Study Group
Technical Report Series, No. 757
1987, 102 pages
ISBN 92 4 120757 4
Sw.fr. 14.-/US $8.40
(Also available in a French edition)

Published by the World Health Organization

Address orders to: World Health Organization, Distribution and Sales, 1211 Geneva 27, Switzerland, or to any of the sales agents listed on inside back cover.