A STUDY OF VACCINATION STATUS, WEIGHTS AND BIRTHPLACE OF CHILDREN AGED 12 TO 23 MONTHS IN THE MOSVOLD HEALTH WARD OF KWAZULU

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ABSTRACT

The objective of the research reported in this thesis was to describe the vaccination coverage of children aged 12 to 23 months in the Mosvold Health Ward of northern KwaZulu. The Expanded Programme on Immunisation cluster sample technique was used. Simultaneous measurements of the children's weights and arm circumferences were done, and their birthplaces noted.

Vaccination coverage rates were generally low; 74 to 83 per cent of the children had had BCG, 47 to 56 per cent had had three doses of DPT, 48 to 57 per cent had had three doses of polio and 47 to 56 per cent had had one dose of measles vaccine. Forty-eight per cent of the children had been born at home. Fifteen per cent had weights which were more than two standard deviations below the median weight-for-age according to NCHS curves, 11 per cent had arm circumferences of 13,5 centimetres or less. The results are compared with other findings from elsewhere in southern Africa.

Relevant literature on vaccination coverage improvement and the measurement thereof, is reviewed. Recommendations are made for increasing coverage rates in the Mosvold Health Ward.

DECLARATION

I hereby declare that this dissertation is my own work and that it has not been submitted to any other institution for any other degree or qualification.

I declare I have properly acknowledged all references used.

Eckhart Johannes Buchmann

31 day of March, 1992.

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PERMISSION

The study was undertaken with the permission of the KwaZulu Health Authorities and local tribal leaders. The approval of the Committee for Research on Human Subjects of the University of the Witwatersrand was also obtained. The necessary documentation appears in the Appendices.

PUBLICATION

The findings of vaccination coverage in the study were published in the South African Medical Journal in: Buchmann EJ, Ngesi N, Tembe R, Gear JSS, Ijsselmuiden CB; Vaccination status of children aged 12-23 months in the Mosvold health ward of KwaZulu. S Afr Med J 1987; 72: 337-338.

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CHAPTER I INTRODUCTION

1. Motivation for the Study

The study was planned primarily to measure vaccination coverage of children in the Mosvold health ward in far northern KwaZulu. The need arose from a concern about two factors:

1. The continuing occurrence of measles as a common and serious disease at the hospital. In 1987 there were 278 measles admissions to the paediatric ward.

2. The impression that large numbers of children were unvaccinated:

    a. many children treated at the hospital were not vaccinated fully;

    b. clinics were very sparsely distributed in the area, and it appeared that a large proportion of the population were living further than five kilometres from clinics.

We intended to measure vaccination coverage by visiting a sample of homes and inquiring into the vaccination status of children aged 12 to 23 months in these households. This would provide data in anticipation of efforts to expand community health services and in particular to make immunisation more available to the children in the region. A field study of this type would also provide us with other opportunities: we were very interested in finding out what proportion of children were born at home, with a view to further research into the local role, if any, of traditional birth attendants. Furthermore, simple measurements such as weights and arm circumferences could be performed on the children sampled, and an indication of nutritional status could be obtained. It was hoped that these measurements would provide useful baseline data. Many underweight children were being admitted to the hospital and we hoped to gain some information on weights and arm circumferences of healthy children in the community

The study would also introduce concepts of scientifically based field research to health workers at the hospital. Further, Mosvold Hospital had carried a very low profile in KwaZulu and faced closure in 1986 owing to a severe shortage of medical staff. We hoped that the study might attract the attention of Head Office to the real health problems of the area, and provide evidence of a serious local commitment to solving some of these problems.

2. Specific Objectives of the Study

In summary, the objectives of the study were:

1. To measure vaccination status of children aged 12 to 23 months, against the six target diseases: tuberculosis, poliomyelitis, tetanus, diphtheria, whooping cough and measles.
2. To study the influence, if any, of living far from clinics on vaccination coverage.
3. To collect simple data on weights and arm circumferences of children aged 12 to 23 months.
4. To measure the rate of home deliveries.
5. To introduce scientific field research methods to hospital health workers.
6. To attract Head Office attention to health problems in the Mosvold Health Ward, and efforts being made to solve them.

A review of relevant literature follows in Chapter II as background to the description of the study. This is divided into two parts:

1. Discussion of efforts to accelerate immunisation efforts.
2. Discussion of the methods used to measure vaccination coverage.

CHAPTER II LITERATURE REVIEW

PART ONE : ACCELERATED IMMUNISATION: THE EXPANDED PROGRAMME ON IMMUNISATION

1. Intrrduction

The immunisation of children against the most common and deadly infectious diseases has been described as the world's most powerful public health technology, and saves the lives of about one million children in developing countries each year.[1,2] Without immunisation, 100 000 African children south of the Sahara will die before their first birthday and a further half-million will be disabled each year.[3] Immunisation is also considered to be one of the most cost-effective health interventions; the more obvious benefits are savings in treatment costs following reduced incidence of disease, reductions in mortality and morbidity with avoidance of suffering and inconvenience to children and their families, and "spill-over" benefits such as improvements in other arms of health services consequent on improved immunisation efforts.[4,5,6,7]

2. The Expanded Programme on Immunisation

The World Health Organisation's Expanded Programme on Immunisation (EPI) originates from the World Health Assembly resolution WHA 27.57 adopted in May 1974. The assembly recommended that member states develop and maintain immunisation and surveillance programmes in respect of the following diseases: Tuberculosis, Poliomyelitis, Diphtheria, Whooping Cough, Tetanus, Measles and Smallpox. A plan was later endorsed to merge the highly successful Smallpox Eradication Programme and the EPI, so that use could be made of the many years' experience of smallpox control.[8]

General programme policies, including the 1990 goal of providing immunisation for all children of the world, were adopted in resolution WHA 30.53, in May 1977. The importance of EPI as an essential component of maternal and child health and Primary Health Care (PHC) was emphasised in resolution WHA 31 53 in May 1978 and in the declaration of Alma-Ata in September 1978.[9]

In February 1982 the assembly warned in resolution WHA 35.21 that progress would have to be accelerated to meet the 1990 goal and urged member states to consider a five-point action programme:

1. Promotion of EPI within the context of PHC.
2. Investment of adequate human resources in immunisation.
3. Investment of adequate financial resources in immunisation.
4. Continuous programme evaluation and adaptation.
5. Pursuit of research and development.

The EPI global advisory group recommended in November 1985 that three general and four specific actions be taken by national programmes to accelerate progress. These were endorsed officially in resolution WHA 39.30 in May 1986:[10,11]

"Three general actions:

1. Promote the achievement of the 1990 goal nationally.
2. Adopt a mix of complementary strategies for programme acceleration
3. Ensure that rapid increases in coverage can be sustained through mechanisms which strengthen the delivery of other primary health care interventions.

Four specific actions:

1. Provide immunisation at every contact point.

2. Reduce drop-out rates between first and last immunisations.
3. Improve immunisation services to the disadvantaged in urban areas.
4. Increase priority for the control of measles, poliomyelitis and neonatal tetanus.

In September 1985, the African regional committee of the EPI declared 1986 as African Immunisation year.[3] Despite many encouraging developments on the continent, prospects for the achievement of the 1990 goal still appeared poor for most of the least developed countries of Africa.[4]

3. EPI in South Africa

South Africa is not a member of the World Health Organisation. Responsibility for immunisation services is divided among 15 different authorities: the State itself, four provincial administrations and four independent and six non-independent national states. A further 800 local authorities also administer their own immunisation services.[18]

Recently a plea was made for a national immunisation policy:

1. Central co-ordination "to counter the enormous

fragmentation" of immunisation services.

2. Detailed standards are needed for programme evaluation; results of evaluations should be calculated at field level and not in central head offices.
3. Immunisation services should be provided at all health service points.
4. Adequate financial and human resources should be invested including training for EPI management.
5. "Consumer demand for immunisation must be increased by extensive health education efforts."
6. "General practitioners must be involved in the execution of the policy as well as the monitoring of the programme."

An additional point was that the EPI in South Africa should be concerned not only with vaccines; "it should be an essential component of PHC and a step towards a more healthy and democratic South Africa."[12]

4. Strategies for Accelerating Vaccination Coverage

Immunisation services in many developing countries have proved hopelessly inadequate.[8] A review of immunisation acceleration strategies in 22 countries in 1988 for the EPI Global Advisory Group highlighted a number of problems:

1. Inadequate planning of services.
2. Administration of large numbers of vaccinations to children too old to benefit from them.
3. High drop-out rates, from earlier to late doses of vaccine.
4. High cost of vaccines, facilities and equipment.
5. Inability to sustain coverage at levels achieved during acceleration campaigns.
6. Disruption of other ongoing activities in PHC by acceleration campaigns.[13]

Most countries in Africa utilise a combined system of fixed and mobile clinics for vaccine delivery. Ninety percent of Africa's rural population lives in small scattered settlements, creating logistical difficulties, compounded by a poor communications infrastructure.[9] A combination of methods should be applied:

1. Promoting and providing immunisation at every health contact in all health facilities in the country.
2. Mobile and outreach services visiting remote rural areas and locations away from existing facilities.

3. Mass campaigns or national immunisation days as:
   a. emergency measures in epidemics;
   b. a catch-up strategy and catalyst for EPI expansion;
   c. ongoing annual or bi-annual campaigns.[2,9,14]

The ability of a country to render such services effectively will necessarily be limited by its health resources and infrastructure. As stated by the World Health Organisation (WHO): "immunisation coverage is also an important indicator of effective health infrastructure. Variations in coverage ... largely reflect differences in the availability of existing health services in each country."[19]

a. <u>Acceptable coverage levels</u>

It is well known that 100 per cent vaccination coverage of a susceptible population is not necessary for eradication of the target disease. At a certain high coverage level, a "herd immunity" is created and transmission of disease is interrupted.[16] Levels of 92 per cent to 96 per cent are required to eliminate measles and pertussis.[16,17] Ninety per cent coverage with polio vaccine will eradicate the disease, if maintained for approximately 12 years.[18] Coverage of 70 per cent with polio and measles vaccine can be expected to maintain the incidence of the diseases at acceptably low levels.[18,17] Herd immunity can be achieved with lower coverage rates in sparsely populated rural areas, but these would be susceptible to epidemics originating from nearby urban settlements, where disease transmission is greatly facilitated by the higher population density.[20] Optimal control therefore needs to centre first on urban areas.[16,21]

Gazankulu, which has an active immunisation programme, set its immediate coverage goal at 85 per cent for 1987, and its "long-term" goal at 97 per cent for 1990.[22] Most African countries have reported vaccination coverage rates which are considerably lower, and an acceptable short-term strategy would be to aim at 70 per cent coverage in an initial effort to contain, rather than eradicate, the vaccine-preventable diseases. A recent evaluation of coverage in Lesotho showed significant improvements between 1982 and 1986. Coverage with polio vaccine rose from 54 per cent to 80 per cent, and that of measles vaccine from 49 per cent to 73 per cent.[23] Coverage rates for other African countries are shown in Table 1.

TABLE 1: VACCINATION COVERAGE: AFRICAN REGION

(January 1988)**

Country	Children less than 1 year of age (%)			
	BCG	DPT3	Polio3	Measles
Botswana	99	86	88	91
Rwanda	92	87	86	78
Zimbabwe	94	79	81	77
Lesotho	86	82	80	73
Kenya	86	75	75	60
Swaziland	91	74	74	74
Tanzania	93	69	65	76
Zambia	92	66	61	58
Malawi	79	66	55	66
Cameroon	77	61	43	39
Burkina Faso	67	34	34	68
Zaire	52	32	33	39
Mozambique	47	29	25	39
Nigeria	42	21	22	32
Uganda	51	21	21	27
Ghana	31	35	17	63
Ethiopia	12	7	7	10
Niger	28	5	6	19
Equatorial Guinea	30	3	4	12
Angola	25	9	N	26

N = No data available
DPT3 = completed full series of three DPT vaccinations before age 1 year
Polio3 = completed full series of three polio vaccinations before age 1 year

b. Mass immunisation campaigns

Mass immunisation campaigns are a rapid, if temporary, means of increasing vaccination coverage. They are effective "fire-fighting" tools in the prevention of spread of epidemics.[25] Campaigns may involve whole societies and set up outreach services for the first time in previously neglected areas.[1] They lead also to conscientisation of communities to demand and expect better health care, and provide high points in the continuing process of health development.[26]

Campaign strategies include:

1. "Accelerated implementation of existing plans."
2. "Use of periodic pulses of intensified activity."
3. National immunisation days.[27]

Campaigns from Burkin Faso, El Salvador and Colombia have been described in detail.[28,29,30] All were very successful in terms of numbers of children vaccinated, but the effects on target disease incidence were not stated in any of these reports. The Burkina Faso "vaccination commando" did, however, lead to an awakening of progress towards effective implementation of PHC in that country. Brazil's polio vaccination campaigns, held on two days every year from 1980 to 1983, brought a steady and sustained decline in poliomyelitis incidence.[31] The ultimate success story of a single-antigen campaign is the worldwide eradication of smallpox. Health workers involved in the Smallpox Eradication Programme were able to concentrate on a single clear objective: the eradication of smallpox in their area.[32]

Certain leading figures in the smallpox eradication effort feel that the smallpox strategy can be applied to the other EPI tar[illegible] diseases. According to them, a ruthless pursu[illegible] a single measurable goal may bring bette[illegible]esults than integrating immunisation into t[illegible] PHC, which includes various other preventive, promotive and curative aspects.[3,33] Oral polio-vaccine has been singled out as ideal for single-antigen campaigns where two days, two months apart, every year, can be set aside for polio vaccination. Since the vaccine is given orally, it may be administered by lay persons with minimal education. Other EPI vaccines, being injectable, need to be given by trained health workers.[33,34] Periodic measles vaccination campaigns, held every three to six months, have also been suggested.[31] Despite this enthusiasm for single-antigen campaigns, some doubt has been expressed about their cost-effectiveness and sustainability.[40] The Brazilian polio campaigns were converted into a multiple-antigen programme in 1984, with the addition of diphtheria, pertussis, tetanus and measles vaccines.[31] The low incremental costs of providing additional vaccinations at the same time and place, was likely to provide the multiple-vaccine programme with greater impact per dollar spent than the single-vaccine programme.[30]

Mass immunisation campaigns have recently met with much criticism. Isolated campaigns, not supported by ongoing sustained immunisation services, may lead to repeated cycles of immunisation followed by epidemics as unimmunised populations grow in the wake of campaigns.[36] This happened in The Gambia in 1967. Three mobile teams vaccinated all children aged six months to four years against measles and the country achieved the distinction of being the first in the world in which measles transmission was interrupted. The success was only temporary and by 1972, measles had reappeared as an endemic disease. Reasons given for this failure included the absence of a health infrastructure, a shortage of vaccines following the campaign and a lack of supervisory skills and resources to maintain mobile operations.[37]

Ofosu-Amaah has suggested that annual polio campaigns in Africa may disrupt immunisation programmes and reverse the trend of integration of EPI into PHC. Such campaigns might prove very expensive, with administrative and logistic ability absent. He advises that African countries should rather continue to build on their existing EPI structures.[38] Colombian workers were similarly concerned that their national compaign would eclipse and detract from the continuous routine vaccination services.[30] The EPI maintains that campaigns require meticulous planning and organisation with political commitment from the highest level. Campaigns should "reinforce not replace the PHC services that must provide immunisation on a regular basis to young children"[39]. The EPI's Global Advisory Group stated in 1985 that campaigns should only be undertaken after considering the "likely long-term impact of such a strategy and the country's ability to implement and maintain the effort".[37] Campaigns, therefore, are only a first acceleration of activity and not a substitute for routine long-term immunisation programmes.[40] While such events may concentrate action for a limited period on clearly identified goals, measures must be created and maintained to become routine activities of the health service and community life.[41]

The question of mass campaigns in South Africa was addressed by Barron et al. They pointed out the poor co-ordination of different health services, the lack of involvement of high profile leaders and minimal community involvement in health, as factors militating against success of mass campaigns in the Republic. They recommended that vaccines continue to be delivered as part of Maternal and Child Health (MCH) services ar that the present health infrastructure be exte ded. Successful MCH services would eliminate the necessity for vaccination campaigns.[39].

c. <u>Routine immunisation services</u>

Rapid increases in vaccination coverage are most easily obtained where the health infrastructure is already developed.[4] According to the EPI, over 50 per cent of children in the world, excluding Africa, receive at least one of the EPI vaccines, and "simply by reinforcing existing health services, there seems to be every reason to expect that immunisation coverage of 60 to 70 per cent will be achieved ... by 1990."[42] Workers in Bophuthatswana feel that the main thrust of immunisation policy should be directed at increasing the frequency of contact between the health services and children during the first nine months of life. Their research showed that frequency of attendances in the first year correlated significantly with vaccination status.[43]

The view that immunisation should be offered as a separate vertical service has been stated by David Henderson, formerly of the Smallpox Eradication Programme. He maintains that immunisation takes a "back seat" to curative care if provided at the same point by the same people who provide other PHC activities.[2] The EPI disagrees and recommends that immunisation be integrated with other PHC functions, and be provided at all facilities where maternal and child health care is offered.[19] The availability of each service, moreover, promotes the use of the other services by the population concerned.[44] Henderson does concede that the integrated approach is more cost-effective; most probably it is the more sensible solution in developing countries where finance and resources are in short supply. Where a health infrastructure does not exist, a vaccination campaign may provide the first introduction of immunisation activity. This needs to be followed by a regular service providing immunisation from fixed or mobile points, acting as building blocks on the way to a permanent integrated PHC service, other components being added one by one in response to popular need or demand.[40,45]

i) Mobile clinics

The children that benefit the most from immunisation services are most frequently those residing near existing health facilities.[46] Tanzanian workers noted that only 35 per cent of the country's population lived within five kilometers of the health units, and that vaccination coverage was considerably lower in areas far from the units.[47] In a Zimbabwean study, long distance from clinics was a leading reason stated by parents for non- immunisation of children.[48]

South Africa's own Regional Health Organisation for Southern Africa (RHOSA) has recommended that MCH services be sited no more than five kilometers or 45 minutes' walk from every inhabitant in Southern Africa.[49] This may be achieved in a rural setting by a two-pronged approach: a central clinic available to those nearby, and a mobile clinic service radiating out from there to well-known fixed stopping points.[50] Mobile child health teams in Gazankulu, each with one driver and two nurses, brought bimonthly immunisation services to within five kilometers of all residents of the national state.[22] Similar teams in Venda have operated successfully from base hospitals, apparently causing a dramatic rise in vaccination coverage.[51]

ii) Private medical practitioners

Private doctors in general or paediatric practice should be involved in the provision of immunisation to eligible children.[12]

Doctors in India provided vaccines at their surgeries during a measles immunisation programme, and performed most of the vaccinations in that campaign.[82] The role of private practitioners in South Africa has not been addressed. They should certainly be urged to check on the vaccination coverage of all children they see and direct those who are eligible, to the nearest vaccination points. The provision of vaccines to these doctors should only be undertaken after careful consideration; they enjoy considerable autonomy in this country and it would be a difficult task to monitor them in terms of vaccine storage and administration, and documentation of vaccinations.

iii) Road-to-health cards

Road-to-health cards, originally used as weight charts, now provide an integrated record of infant and child health, including details of vaccinations and illnesses. This obviates the problem where immunisation is seen as an end in itself, such as when a separate immunisation card is used. The card should be of meaning to the mother and fully comprehensible to health workers.[83] Visual codes may be used on the cards for the benefit of illiterate mothers, so improving their understanding of immunisation and hen:e their motivation for completing their children's vaccination schedules.[84]

d. Drop-out rates

The reduction of drop-out rates between the first and last vaccinations in the schedule was one of the four specific actions recommended by the EPI in 1985. It was suggested that, to reduce drop-out rates, health workers should:

1. Strengthen participation of communities in immunisation programmes.
2. Provide services at more convenient times and places and at regularly scheduled "outreach" clinics.
3. Better inform parents of the need to return for repeat vaccination.
4. Identify children who are eligible for immunisation and actively seek out those who are missed.[10]

High drop-out rates have been ascribed to long distances from clinics, long waiting times, poor communication and poor facilities. Systems for identifying and following up defaulters are not in place in developing countries.[95] Zambian clinics declared fully vaccinated children as "protected", and entered them in a separate column of their register. "Protected" children received a star on their cards as a form of recognition for completed vaccination. This motivated the health workers to educate mothers to return for repeat vaccination, and clinics could measure their achievements by counting the number of "protected" children in their register.[96] It has also been suggested in Gazankulu that completed vaccination be made an entrance requirement for primary school.[97] Completion of the immunisation schedule may also be facilitated by manipulation of the schedule itself (see below).

e. Vaccination schedules

Regarding diphtheria, pertussis, tetanus (DPT) and polio vaccines, the vaccination schedules recommended by the World Health Organisation (WHO) differ from those in South Africa in the timing of the first three combined doses.[49,98] The WHO recommends that the three doses be given at six, ten and fourteen weeks of age, while current policy in South Africa dictates they be administered at three, four-and-a-half and six months (13, 19 and 26 weeks). Vaccine efficacy is equivalent in the two methods, but the former carries the advantage, not only of protecting infants at an earlier age, but also improving compliance and higher completion rates when given to younger children who occupy more of their mothers' attention and are easier to carry to clinics.[39] There seems to be little reason why South Africa should not adopt the WHO protocol.

WHO and South African policies on measles vaccination are identical. The nine-month recommended age presents a problem, as it follows very late on the primary DPT and polio series. At this age a mothers' early enthusiasm for immunisation may have waned and the child is both "too young to walk and too old to carry" to the nearest clinic.[44] An earlier vaccination age may become possible with new vaccines administered at six months of age using injections or an aerosol.[60,61,62] These methods are still uneconomic, however, and difficulty has also been experienced in the production of masks and canisters for aerosol vaccination.[63]

A compromise vaccination schedule has been applied with relative success in West Africa.[44] Satisfactory vaccine efficacy was achieved with only two doses of DPT and injectable polio vaccine. This "simplified EPI" was found to be a cost-effective alternative to the conventional schedule in countries with very sparse health services and dispersed populations. It certainly should not be recommended for South Africa with its relatively well developed economic and health infrastructure.

f. <u>Opportunities for vaccination</u>

The idea that illness contraindicates vaccination pervades the thinking of many health workers.[45] The WHO and EPI have repeatedly emphasised the need to use every opportunity to vaccinate children.[13,15,46] It has been clearly demonstrated that ill and malnourished children suffer no worse side-effects than well children when immunised with the EPI vaccines.[30,47] Sero-conversion rates are also not affected by poor nutrition status.[47] Contact with health care institutions and particularly admission to paediatric wards, play an important role in measles transmission. In a Guinea-Bissau study, 30 per cent of measles deaths were traced back to the paediatric ward of the hospital.[68] All children, including those who are severely ill, should be vaccinated against measles on admission if found to be eligible.[69,70]

The EPI recommendations on vaccine administration serve as the most useful guidelines (Brazzaville 1982):

All children attending health facilities should be considered eligible for vaccination particularly in regions:

1. with a high incidence and severity of target diseases;
2. where access to health care is limited;
3. where vaccination coverage is low;
4. where children only come into contact with health services in times of illness;
5. where attendance at health facilities is an important factor in the spread of the infectious diseases of childhood.[68]

In 1987, the EPI, in its global status report, recommended that it was most important to:

1. Provide immunisation at all facilities attending women and children.
2. Vaccinate children with minor illness or malnutrition.
3. Vaccinate as early in life as possible.
4. Open a new multidose vial of vaccine for even one eligible child.[18]

g. Management and training

Adequate investment of human resources was listed as second on the EPI five-point action plan in 1982.[7] Clearly, .d improvement in vaccination coverage can best be achieved by a well managed programme.[69] This appears to be a major stumbling block in developing countries. Halfdan Mahler, then director-general of WHO, said in 1986 that management capacity within national programmes was the most serious bottleneck in EPI implementation and WHO reported that lack of management skills remained the most serious constraint in the investment of human and financial resources.[39,71] Stephen Jarrett, formerly of the Smallpox Eradication Programme, pointed out that good management (of information, personnel and material resources) played a greater role in the smallpox eradication effort than finance.[72] An evaluation of a failed immunisation programme in Nigeria revealed poor management as the major cause; there was poor integration into the local health infrastructure, resulting from lack of consultation with local authorities; publicity was inadequate and vehicles were allowed to break down.[73]

The joint WHO/UNICEF document "Planning Principles for Acceleration of Immunisation Activities" contains very important guidelines for senior managers of immunisation programmes. It discusses planning, sustainability of services, adequate staff training, programme advertising and management of supplies and equipment. It also deals with the planning of national immunisation days.[34,74] According to EPI director, Ralph Henderson, senior and middle managers "require appropriate training, and should apply what they have learned by visiting, training, motivating and monitoring the performance of those for whom they are responsible - a formidable task in countries where competent managers are scarce."[44]

The EPI has provided training materials for middle level managers which provide comprehensive practical exercises and approaches for fieldworkers in developing countries.[78] These should be disseminated to field staff, volunteer community workers, practitioners outside the health system, and to health workers in training, including medical students.[10] A recent EPI update set out a four-point checklist for supervisors in the field.

"Superviors can use four questions as a check list for action:

1. Who is being served by the programme?
2. Who should be served by the programme?
3. Are the target diseases occurring?
4. Are supplies and equipment adequate?"

From 1974 to 1986, over 17 000 health workers were trained worldwide in EPI management techniques.[74] Locally, Gazankulu implemented its immunisation policy in 1987, and appointed a programme co-ordinator at head office level. Training courses were held at all Gazankulu hospitals, the nursing college, and head-office. Quarterly progress meetings are held and hospitals visited regularly by the co-ordinator. Fieldworkers participate in the evaluation of coverage, providing rapid feedback and hence opportunities to improve coverage.[22] A call has been made recently for central programme planning and co-ordination in South Africa. "Immunisation officers should be appointed to national, regional and local offices and they must have adequate authority and resources to initiate and implement adequate vaccination services, within the context of PHC, to all the people of South Africa".[77] An integration of the fragmented South African health services would facilitate the appointment of such officers.

h. <u>Communication strategies and social mobilisation</u>

A successful vaccination programme needs not only good quantity and quality of vaccines and an efficient health service, but also an acceptance by communities of the obvious value of vaccination.[78] Clearly, parents need to be aware of the benefits of vaccinating their children, where and when services are available and at what age children should receive the vaccines.[3] This is a fairly simple matter in a well-functioning system which has already achieved universal coverage, but in launching new programmes and revitalising stagnant services, total social mobilisation is necessary to transform immunisation from a public health measure into a "revolutionary social movement".[78] The Alma-Ata declaration emphasises the need for communities to participate actively in the provision of their own health services.[79] This can only be brought about through effective communication strategies.

i) Political will

The involvement of political and national leaders can contribute considerably to greater acceptance of immunisation by parents.[1,15] Ralph Henderson has said that "leaders of developing countries must be made sensitive to the death and suffering being caused by the vaccine-preventable diseases and to the fact that today this suffering is needless."[44]

The Tanzanian president recently declared EPI as a priority programme in his country, and the head of state of Burkina Faso was personally involved in the national "Vaccination Commando."[28,80] The most remarkable example of "political will" comes from El Salvador, where government forces and guerillas agreed to a truce in the civil war to allow three vaccination days to be held throughout the country.[29]

The political significance of immunisation is controversial. The proponents of UNICEF's Child Survival and Development Revolution (CSDR) and the GOBI programme (Growth Charts, Oral Rehydration, Breastfeeding, Immunisation) believe that the success of CSDR can provide a leading edge for greater reforms in all basic needs.[91] Immunisation strategies confront some of the causes of underdevelopment and can lead to mobilisation of politicians, professionals and the public to address the issues central to the human right of freedom from disease.[41] David Werner however, feels that the causes of poverty and malnutrition are not being addressed by the CSDR, and that selective primary health care, such as Oral Rehydration Therapy and immunisation, places more control in the hands of central authorities, businessmen and foreign "experts". In some of the more repressive countries, soldiers and security police have been mobilised to participate in mass immunisation campaigns. Werner says that the CSDR "has the potential to undermine the basis for PHC which calls for a truly revolutionary mobilisation of people in the struggle for a healthier more just social and economic order". He believes that immunisation should be integrated into "people-centred approaches which are part of a global struggle for the redistribution of resources and power."[63] Werner appears to disagree more with the method of implementation of the CSDR than with its ultimate objectives.

In South Africa, the question of political will in immunisation is complicated by the racial political structure and its effect on the health care system. The inadequate allocation and maldistribution of health services has contributed to poor health conditions among the less privileged groups, particularly rural blacks.[64] These people, who would benefit most from effective implementation of EPI in this country, cannot in the present political climate influence political will to improve immunisation and other health services to them.[12]

ii) Customs and attitudes

A successful vaccination programme must take into account the customs and traditions of the community that is to be served. Communities frequently resist imposed knowledge and technology; it is important first to understand and utilise the knowledge and experience of health matters already existing in the target population.[94] Areas of agreement with health-workers' conventional knowledge should be sought. In introducing immunisation to village and rural people, explanations on causation and prevention of disease should be offered as an alternative, not as a replacement, of traditional knowledge. Immunisation may be difficult to explain, for lack of vernacular terminology, and analogies may need to be used.[95] Surveys of attitudes to measles and immunisation in Nigeria, Honduras, Zimbabwe and Gazankulu aided health workers in providing a more effective vaccination programme.[48,54,94,97] The Gazankulu study revealed a local belief that all children should contract measles at a young age, to prevent serious complications in later life. Health workers then had to explain to parents that the vaccine did not prevent measles, but that it caused a mild form of the disease and therefore protected the child against serious complications.[97]

iii) Active community involvement

Active public participation in immunisation programmes should be encouraged. Communities can support from local resources the financing of buildings, petrol and salaries and so benefit from immunisation services, when governments lack finance at the time. While such contributions may engender a feeling of pride in communities in "their own" immunisation services, governments should still accept the major responsibility to provide services for those in need.[66] Community members can also become involved in spreading the message about immunisation. Lay care group members in Venda and Gazankulu are in contact with their local clinics or hospitals and encourage vaccination of children among neighbouring families.[22,51] In Colombia, respected community members accompanied health workers to homes in villages and rural areas and directed unimmunised children to their nearest clinics for vaccination. This method, known as "channelling", significanlty improved vaccination coverage. Channelling, like other means of community participation, involves ordinary people and is transitional to the ideal of prevention and self-care.[98]

iv) Non-government organisations

Welfare and charitable organisations can provide valuable assistance to governments in implementing EPI.[1] The role of such organisations (NGO's) needs to be clearly defined within each country's programme. The EPI recommends that national action plans and co-ordinating committees of all agencies should be established to ensure optimum effect and minimal duplication of activity.[10] The Red Cross and Red Crescent societies are frequently involved in immunisation programmes. They have a flexibility that governments lack, particularly in lobbying, arranging finance, health education, training and information collection and dissemination.[97] Rotary International has assisted governments with polio vaccination since 1980. Its PolioPlus programme has achieved commendable results worldwide.[99] David Werner has however warned NGO's to think carefully before "joining the bandwagon" of selective PHC. The actions of NGO's should help empower communities to overcome injustice, rather than force a dependence on technologies such as oral rehydration packets and immunisation.[82]

v) The media and marketing strategies

The mass media provide a v luable vehicle for spreading information about immunisation. Vaccination programmes in El Salvador, Burkina Faso and Honduras all relied heavily on radio messages and printed materials.[20,29,84] Village theatre was also used in Burkina Faso. A song specially composed to promote child health was broadcast in Ecuador to promote awareness among parents.[2] Comic strips on immunisation have been used in India to overcome the literacy barrier, and puppet shows were reported to be successful there in improving acceptance of smallpox vaccination.[91,92] The use of mass media and other advertising strategies demands careful planning and can prove very costly. National experts in communications, advertising and marketing should be consulted about research, design, production and distribution of materials and messages about immunisation.[2,15]

vi) Schoolchildren

Schoolchildren and particularly girls as future mothers, have been singled out for special attention in health education. Not only will well-educated children be more responsible adults, they are also effective conveyers of health messages to their parents.[22,36,66] A schools health programme in Bombay demonstrated the remarkable effect that health education of schoolchildren had on immunisation coverage of infants. Children brought their mothers and infant siblings to the school where vaccinations were performed. A 90 per cent success rate was reported.[93] School health services therefore have a potential which goes beyond the health of the children themselves. Schools and day-care centres can also assist in improving vaccination coverage by ensuring that all children admitted be fully vaccinated.[87,94]

PART TWO : EVALUATION OF VACCINATION COVERAGE

1. Introduction

Vaccination programmes aim to achieve a marked reduction in target disease incidence. This requires the greatest possible coverage of the population at risk with potent vaccine.

Evaluation of vaccination programmes includes data or surveys of:

1. Process: a. Vaccination coverage
   b. Vaccination techniques and the cold chain
2. Outcome: a. Serological immunity of vaccines
   b. Target disease incidence

This review is concerned only with measurement of vaccination coverage, with particular emphasis on rural African conditions.

Two main methods of evaluation systems are commonly used:

1. Routine recordings of vaccinations by field staff

2. Sample surveys

2. Routine Recording of Vaccinations by Field-staff

This method forms the basis of official South African data, and annual summaries are published by the Department of National Health and Population Development for the entire country excluding the national states.

Vaccinations performed in the field are recorded by vaccinators who add up totals of doses of each vaccine given and submit these periodically to regional centres, where regional totals are added up and sent on to national head-office. In South Africa, vaccination returns are sent in from municipalities in the seven health regions of the Republic and consecutive levels in the hierarchy of control are called upon to summarise the information on the same vaccination return form. This includes a breakdown of the racial group of vaccinees.[73] These returns are matched against the total eligible population (children under one year of age) in each region.[74] Given the number of births in any community, it is possible to estimate the eligible population.[75] The government's Central Statistical Services can also provide an estimate of eligible population based upon the total population of the region or area in question.[27] A vaccination coverage rate can therefore be calculated:

$$\text{Vaccination coverage} = \frac{\text{no. of persons receiving vaccine}}{\text{population eligible for vaccination}}$$

This method has obvious advantages. Integrated into routine vaccination activities, it costs very little. It involves field-staff in evaluation of coverage and may motivate them to improve performance. Gazankulu field staff, for example, are expected to know the size of the eligible population in the villages they serve, and estimate coverage rates in their areas, giving reasons and suggesting solutions when coverage rates are low.[23] Another advantage of this method is its repeatability; reliable trends may be established over months or years, provided that data collection methods remain the same and staff are properly trained and motivated.

Examination of official South African statistics reveals a number of difficulties. Reported estimates of vaccination coverage exceeding 100 per cent occur frequently, and are most marked among Natal Blacks.[70] Explanations offered for this were an inflated numerator, or an erroneous denominator. Numerator problems were ascribed to some children being counted twice, or children from outside the pre-requisite age group being vaccinated (children over a year old). It is also possible that children from outside areas attended for vaccination. Thousands of children from Kwa Zulu could, for example, attend clinics in neighbouring Natal areas and raise the apparent coverage rate. In such circumstances, KwaZulu coverage would, of course, appear artificially low. An erroneous denominator is frequently a problem in rural African regions where reliable population and birth estimates are unavailable.[99] The author of the national immunisation returns accepts these shortcomings but feels that the methodology can identify problem groups and areas and provide data which can only be "to the common good - spots and all".[98]

Ijsselmuiden and his colleagues suggest that cluster-sample surveys may be performed to test the validity of coverage calculations based on routinely collected data.[77] Workers in Cameroon and Zimbabwe found that their sample survey figures compared well with the routine data from the immunisation service.[48,100] A similar comparison from Indonesia demonstrated a wide discrepancy between the results of a cluster sample survey and official data based on doses of vaccine given and estimates of eligible population.[101] No such comparisons have yet been reported in South Africa.

Ideally, vaccination coverage should be calculated from routinely collected data. This can however only be done reliably if population size is known and data are properly collected. In the absence of these conditions, cluster sample vaccination coverage surveys are recommended.[77]

3. Sampling Methods

An accurate measurement of vaccination coverage of a population of children would ideally require random selection from a complete numerical inventory of eligible children within the defined geographical area, as a simple random sample.[102] This is virtually impossible in developing countries, where basic demographic data are lacking and where lists of populations, house numbers and directories do not exist to provide sampling frames.[99]

The EPI has therefore developed a cluster sample technique in an attempt to gather information quickly and cheaply, in a relatively standardised manner, which can be used in different countries and regions, facilitating comparison of results worldwide.

Furthermore, trends in vaccination coverage can be detected if repeat surveys are performed in the same area. Lemeshow and Robinson have reviewed this methodology and provide a practical guide to its implementation.[103] The EPI technique involves the random selection of 30 clusters of 7 children each, a sample of 210 children. The survey method gives results with 95 per cent confidence limits of about 10 percentage points above and below the observed vaccination coverage rate. Similar confidence limits apply to a simple random sample of 96 children.

A detailed description of the field methodology for cluster sampling is now given.

The study population, eligible age groups and clusters must be identified. A reasonably accurate population estimate is required for each cluster. The clusters are selected with probability proportional to size. A household is picked at random from all households in the cluster, preferably after census and allocation of numbers to households, and is designated as the starting point for the cluster. Where this is not possible, it is suggested that a centrally located landmark is chosen in the village or town and that the observer randomly selects a direction to walk and then counts households on the way to the edge of the settlement. Upon entering the starting household, information is collected about the vaccination status of eligible children. The observer proceeds from there to the next nearest household (whose front door is closest to that of the home just visited). This is repeated with subsequent households until seven eligible children are found. In households with more than one eligible child, all children are added to the cluster, even in the final household where this would increase the cluster size to more than seven. There is no provision for revisiting a household where no-one is at home.

a. <u>Problems with the EPI methodology</u>

i) Selection of clusters and households

While cluster selection is largely random, household selection is not; the selected households are all adjacent to each other. Pockets of vaccinated or unvaccinated children may be selected and provide an unrepresentative picture of the cluster. Lemeshow and Robinson feel that such discrepancies probably cancel each other out over the thirty clusters.[102] An Indonesian survey compared the EPI method to one in which seven households were randomly chosen within each of the 30 clusters. The latter method was found to be 1,4 to 2,5 times more expensive, although more precise.[101] The EPI method has also been evaluated and compared to a simple random sample (SRS) strategy using computer simulation. Five hypothetical populations were constructed and 500 samples were drawn from these and the methods compared: the SRS performed consistently better, but the EPI method was in only 40 out of 2 500 samples outside the range of 10 percentage points above or below the actual coverage level. Pocketing of immunised children in largely unimmunised populations had a striking effect on the accuracy of the EPI method. In a "worst case" situation, with a high density, low coverage population, with pockets of immunised children in all clusters, the EPI method performed particularly poorly. In mitigation, the authors suggest that it is most unlikely that any real population would even closely resemble the postulated "worst case". They conclude that the EPI method does achieve its objective satisfactorily.[102] Henderson and Sundaresan drew a similar conclusion in their analysis of the EPI method in 60 actual and 1 500 computer-simulated surveys. They also provided a table to indicate coverage levels necessary in a second survey to establish statistically significant change from coverage observed in a first survey.[104] This table can be recommended for use by programme managers, as it takes into account the "design effect" which would otherwise need to be calculated before results from two cluster samples could be compared for statistically significant differences.

Lemeshow and Robinson emphasise that the EPI cluster method is not a random sample and that it measures overall coverage for the whole population studied. Coverage estimates within the sample should not be disaggregated and clusters or groups of clusters cannot be reliably compared with other clusters in the same study population.[103] The EPI methodology is a compromise suited to conditions in developing countries; where population registration and infrastructure is highly organised and sampling frames are easily obtained, a SRS is the method of choice. A SRS of 96 children provides estimates as accurate as thore of the 30 by 7 EPI method.[97,105]

ii) Selection of starting points in clusters

Where population density is low and households widely scattered, as in much of rural Africa, it becomes impossible for the observer to walk from the centre of a village to the edge and count households. Village boundaries and centres, if they exist at all, are often poorly defined. Lemeshow and Robinson recommend that in such a situation, the observer should randomly choose a direction from the arbitrarily selected centre of the village, and, without counting, take the first household as the starting point for the cluster.[102] From experience in Kenya, Kok pointed out that this would introduce bias towards households near the centre of the village, where immunisation services are likely to be situated. His solution to the problem is discussed below under "modified EPI methodology".[108]

iii) Revisiting households

There is no provision to revisit households where no-one was at home. This may be problematic where large numbers of children are found to be away when observers visit the households. Indeed, Lemeshow and Robinson point out in their review that these households may contain subgroups with different characteristics of vaccination uptake and attitudes.[103]

iv) Undocumented evidence of vaccination

Observers expect to find details of vaccination on the children's Road-to-health Cards (RTHC's). Frequently, however, all that is available is a history of vaccination given by the mother or guardian; the card may be lost. Various approaches have been used: workers in Gambia, Rwanda and Zimbabwe considered children vaccinated only if this was recorded on a RTHC, although the Zimbabwean observers did accept a BCG scar as evidence of vaccination against tuberculosis.[40,106,107] In a Bophuthatswana survey, children who were allegedly vaccinated but had no cards, were completely excluded from the sample and overlooked.[108] In surveys in Zambia and Gazankulu, a history of vaccination was accepted as evidence of vaccination.[109,110] Whatever approach is adopted, this should be clearly stated in the study description and taken into account when analysing the results.

b. Analysis of timing of vaccinations

Some researchers include in their EPI surveys a consideration of the timing of vaccinations. Clearly a measles vaccine administered at two months of age, for example, would not render that child immune. The Zimbabwean workers stated that a child vaccinated at the wrong time would be considered unvaccinated in their data. They set lower age limits for each vaccine according to the Zimbabwean vaccination protocol.[49] The Bophuthatswanan researchers also added upper age limits according to their protocol.[108] Their lower limits for DPT 1 and Polio 1 doses were set at two-and-a-half months. This does not take into account that these vaccines are effective if given at six, ten and fourteen weeks of age, as recommended by the WHO.[87] Perhaps the most useful age limits are those set by Zambian workers, based on the WHO recommendations[111]:

Children are correctly immunised if:

1. The first DPT/Polio vaccine is given after six weeks of age.
2. There is at least a four-week interval between each of the three DPT/Polio vaccine administrations. There is no set maximum interval between doses.
3. Measles vaccine is given after eight months of age.
4. All eight vaccine doses are given before twelve months of age.

c. <u>The modified EPI methodology</u>

Kok's problems with the application of the EPI sampling method in scattered rural populations led him to modify the technique based on the assumption that the Standard One primary school child is the "most randomly and proportionately distributed sampling unit in the community". This assumption needs to be tested because if school attendance rates are low or if certain areas have a particularly low level of schooling, the sampling method would be defective. School attendance and population data are therefore necessary to calculate attendance rates. The primary school population estimate is obtained from the local education department and divided by official population estimates for the five to fourteen year age group in the area, to determine the attendance rate. A rate of over 70 per cent is acceptable for the modified EPI methodology. A cumulative list of school populations is then made and "divided by the number of clusters needed (thirty) to determine a sampling interval (a). Likewise, a random number (n) is selected within the size of the sampling interval", and a sampling interval is added to that and subsequent numbers, so that the "first school selected is the one attended by the nth child, the second is the one attended by the (nth + a) child, the third by the (nth + 2a), etc, till thirty schools have been identified." On the day of the survey, the observers visit a chosen school and randomly pick a child from the Standard One attendance list and ask the child to direct the observers to his or her house. To avoid bias, the next nearest household is chosen as the starting point for the cluster, and vaccination details are asked. Further households are visited in the normal way until seven children of the desired age group have been surveyed.[109]

Ijsselmuiden applied the modified EPI methodology to Gazankulu, using Grade One school children; 24 clusters of 20 children each were studied. He lists advantages of the modified EPI method: up-to-date maps are not needed; village and population data are not essential; it is easier to learn and can be applied by persons with relatively little training in epidemiological technique.[97]

The modified EPI method shows some promise for rural areas with scattered population, but frequently it is these particular areas in which low school attendance rates are found, with very unreliable population estimates. The epidemiological constraints described by Ekanem are seemingly impossible to overcome in such circumstances.[99]

d. <u>Lot Quality Assurance sampling technique (LQA)</u>

Mentioned by Lemeshow and Robinson, the LQA method may be used to determine whether or not vaccination coverage is below a certain predetermined target level. A random sample of individuals is selected from the population, and, based on the results, the population or "lot" is rejected if the sample fails to achieve the target.[103] In the Indonesian analysis of methods of sampling for coverage surveys, the LQA technique was also tested. For example, if, of a simple random sample of seven children, three are vaccinated, the group can be classified with 95 per cent confidence as belonging to a population with coverage rate between 13 per cent and 66 per cent. If all seven of the children in the sample are vaccinated, the confidence limits then become 65 per cent and 100 per cent. LQA is therefore an application of SRS, with confidence limits depending on sample size. Immunisation programme managers can use this method for "spot-checks" in certain areas to find out if coverage is not below a certain level.[101]

4. Summary

In developing countries the EPI sampling technique is the most extensively used method in estimating vaccination coverage. Modifications based on primary school attendance appear acceptable provided all conditions are met. Where social infrastructure and population data are well developed, simple random samples would be more appropriate and economic to perform, although in these areas coverage should ideally be calculated from routinely collected data of doses of vaccine given. While achievement of high vaccination coverage rates is seen as a useful objective, the ultimate indication of a successful vaccination programme is a reduction in the target disease incidence. As stated by the EPI's Global Advisory Group in 1987, "the time has come for many national programmes to shift the primary concern of the EPI from immunisation coverage to disease control".[98]

CHAPTER III METHODS

1. The Study Region

Mosvold Hospital is a 153-bed district general hospital serving some 60 000 people in the far north of KwaZulu. It provides comprehensive primary and secondary care facilities and is situated on the crest of the Lebombo mountains in the village of Ingwavuma. Three fixed clinics at Ndumu, Manyiseni and Gwaliweni provide 24-hour primary care services, while seven mobile clinic points, each visited fortnightly by a team of nurses, supply basic preventive and curative services. A school health team visits schools on a regular basis and lay community health workers are undergoing training by hospital-based facilitators.

Mosvold Health Ward comprises about 2 000 square kilometres of lowveld bush country, its boundaries being demarcated by the Mozambiquean border in the north, the Swaziland border to the west and the Pongolo River course to the south and east. The western half of the Ward is mountainous with a relatively flat plateau, while the eastern half is flat and fairly dry, with a very hot climate. In Figure 1, a simple map illustrates the important

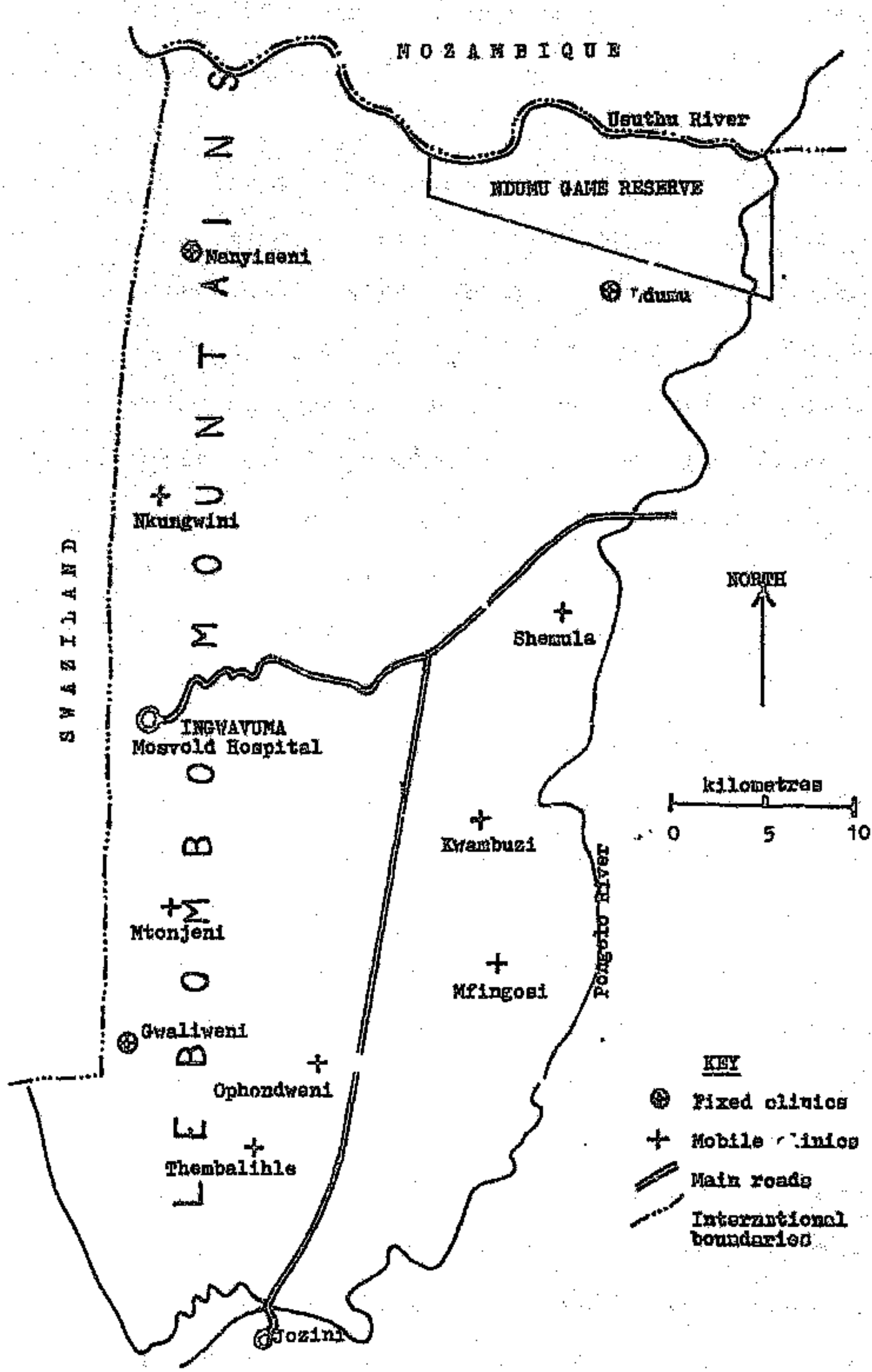

Figure 1. Map of Mosvold Health Ward

features and location of the health facilities in the Study Region.

The people are Zulu-speaking and li in scattered traditional rural settlements. With the exception of Ingwavuma, there are no clearly define villages. Each homestead is surrounded by its own fields and grazing areas, with most families owning cattle or goats and growing crops, usually maize, sugar, beans and groundnuts. The administrative capital, Ingwavuma, is a village with a population of less than one thousand, most of whom are civil servants and their families, and prisoners. All remaining land, with the exception of Ndumu Game Reserve which is run by the Natal Parks Board, is tribally administered by indunas (headmen) under their inkosis (chiefs).

The infrastructure is poorly developed. A few main roads link up the larger settlements, while numerous tracks of variable quality are maintained by the communities themselves and can only be negotiated in robust vehicles. These tracks, however, provide access to almost every settlement in the Health Ward and are critical for the continuation of the mobile and school health services.

utside of pastoral work, employment opportunities are few, with the KwaZulu government and Natal Parks Board providing most of the local jobs. Much of the male population is engaged in migrant labour in the mining, industrial and agricultural sectors elsewhere in Natal and Transvaal.

a. <u>Maternal and child health services, including immunisation</u>

Mosvold Hospital is responsible for the provision of all maternal and child health care services in the Health Ward. The hospital has maternity and paediatric wards, and performs about 100 deliveries every month. Weekly antenatal, postnatal and under-five clinics are held. Vaccination of eligible children is also provided on general outpatient days, but mothers are encouraged to bring their children to the Thursday under-five clinic. Children of over nine months admitted to the paediatric ward without proof of vaccination against measles, are given the vaccine on admission.

The three fixed clinics also hold weekly antenatal, postnatal and under-five clinics. These are smaller and less formal than the hospital clinics and provide better opportunities for patient education. The clinics are each staffed by about eight nurses, one of whom is a trained "Primary Health Care" sister.

The mobile clinics are staffed by a driver and seven nurses and a full day is spent every fortnight at each clinic point. The clinics offer preventive services and also treatment of minor ailments. The buildings used are hired free from the local community, and range in quality from mud-and-iron structures to modern houses. The mobile clinics perform the bulk of antenatal care and immunisations and tend to be extremely busy.

During 1985, the KwaZulu government set up a community health worker training programme. From Mosvold Hospital, one staff-nurse was chosen to be trained as a "community health worker facilitator" at the Amatikulu centre near Stanger. Her task is the training of lay community health workers (CHW's). After first establishing community health committees from the local communities, she will train the elected CHW in basic preventive and promotive health. It is hoped that by the early 1990s , the entire health ward will be served by CHW's, each providing care and advice to about 100 to 150 households. The CHW's will be paid by their tribal authorities with money provided by the KwaZulu government.

b. <u>The KwaZulu immunisation service</u>

There is no specially designated immunisation officer for KwaZulu. Central control is in the hands of the Senior Medical Officer for infectious diseases, with assistance from the principal pharmacist. From their office, immunisation policy guidelines are sent to all KwaZulu hospitals, and specific circulars are available concerning vaccination schedules, cold chain maintenance and vaccine stock management. Vaccination services are provided against the six EPI target diseases: tuberculosis, poliomyelitis, diphtheria, whooping cough, tetanus and measles.

The vaccination schedule for under-fives is shown below:

Birth	:	BCG/Polio
3 months	:	DWT/Polio/BCG
4 1/2 months	:	DWT/Polio
6 months	:	DWT/Polio
9 months	:	Measles
18 months	:	DWT/Polio
5 years	:	DT/Polio/BCG

(D=Diphtheria, W=Whooping cough, T=Tetanus)

Mosvold Hospital has no immunisation officer. Immunisation services at the fixed and mobile clinics are the responsibility of the Community Health nurse in charge, who also manages all other aspects of clinic work. Vaccinations performed at the hospital are the responsibility of the nurse in charge of the Outpatients department. The hospital dispensary ensures the supply of adequate potent vaccine, which is obtained from the regional store at Ngwelezana Hospital at Empangeni and brought in cool-boxes by road. No thermometers or other devices are being used at present to monitor effectiveness of the cold-chain during transport and storage of vaccines. Clinic and hospital refrigerators are serviced by the hospital maintenance section.

Clinic and out-patients staff record all vaccine doses given. Returns are submitted monthly to the matron, and sent on to the nursing section of the Department of Health, Head Office, in Ulundi. As yet, no calculations have ever been made on the basis of these figures and KwaZulu, therefore, has no official vaccination coverage statistics.

2. Methodology

The specific objectives of the study were set out in Chapter II.

The study population was defined as all children aged 12 to 23 months, staying in the Mosvold Health ward at the time of the study. We chose the EPI cluster sample method, which involves the random selection of 30 clusters of 7 children each. The study was planned for October 1986, before the onset of the first heavy summer rains. We expected that there would be minimal agricultural activity at the time, and that most mothers and their small children would be at home during the daytime.

a. Cluster selection

The EPI recommends that clusters be randomly selected with the probability proportional to the size of the population of each cluster. The method has as its basis the selection of villages as clusters. This presents no problems when villages are discrete and their population sizes known. In Mosvold Health Ward there are no villages; households are widely scattered over the countryside and available population data do not indicate how areas were subdivided for census purposes. Primary school attendance rates were also not known and so the modified EPI method, which uses school children as random units, could not be applied.

We decided, therefore, to construct a grid map of the Health Ward; government- issued 1:50 000 topographical maps, last updated in 1980, were divided into "squares" of three minutes latitude by three minutes longitude. Each square thus measured approximately 5,0 kilometres by 5,5 kilometres. 74 squares were generated in this way, providing a sampling frame for the selection of 30 clusters. Squares, instead of villages, would be selected as clusters for the sample. The population of each square had to be determined, so that clusters could be selected with probability proportional to size. The government maps supply fairly detailed information and are based on aerial photographs. On these maps, each small black dot represents a homestead or household. Homesteads were counted and a total was obtained for each square, providing an estimate of homestead density. We made the assumption that the number of occupants per homestead was uniform throughout the Health Ward, and therefore, that population density was proportional to homestead density in all squares. We also assumed that homestead densities had not changed since 1980, since there had been no major movements of people since then; no resettlement projects had taken place, nor had there been any influx of refugees, nor any important agricultural or industrial developments.

We counted 6756 homesteads on the map. An arbitrary total population estimate of 60 000 was accepted (1985 census total was 54 456, and excluded migrant labourers), and this gave a mean homestead occupancy of just under nine persons.

The population of each square was calculated:

$$\text{Population} = \begin{array}{l}\text{no. of home-}\\ \text{steads in}\\ \text{square}\end{array} \times \frac{60\ 000}{6\ 756}$$

A complete list of squares with their populations was then available. Eight squares with populations of 300 or less were excluded, as we expected severe problems in finding seven eligible children, owing to their sparse homestead density. These eight squares, which also included the Game Reserve, had a population of less than 1 000, or 1,6 per cent of the total.

Numbers were allocated to the remaining 66 squares as follows:

Population estimate

301 to 900	:	1 number
901 to 1500	:	2 numbers
1501 to 2100	:	3 numbers
2101 to 2700	:	4 numbers

This can be better app eciated by reference to Figure 2 and Table 2 which show a grid map of the Health Ward with a list of squares, their estimated populations and allocated numbers.

102 numbers were allocated to the 66 squares. Numbers up to 102 were drawn in sequence from a random number table until 30 squares had been selected. Individual numbers could not be repeated, but individual squares could be chosen more than once as long as two or more of the 102 numbers had been allocated to them. In this way, the more populous squares had a greater chance of being selected, and a greater chance of being selected more than once. The squares which were selected are marked with asterisks in Table 2. Where a square was chosen twice, two asterisks appear.

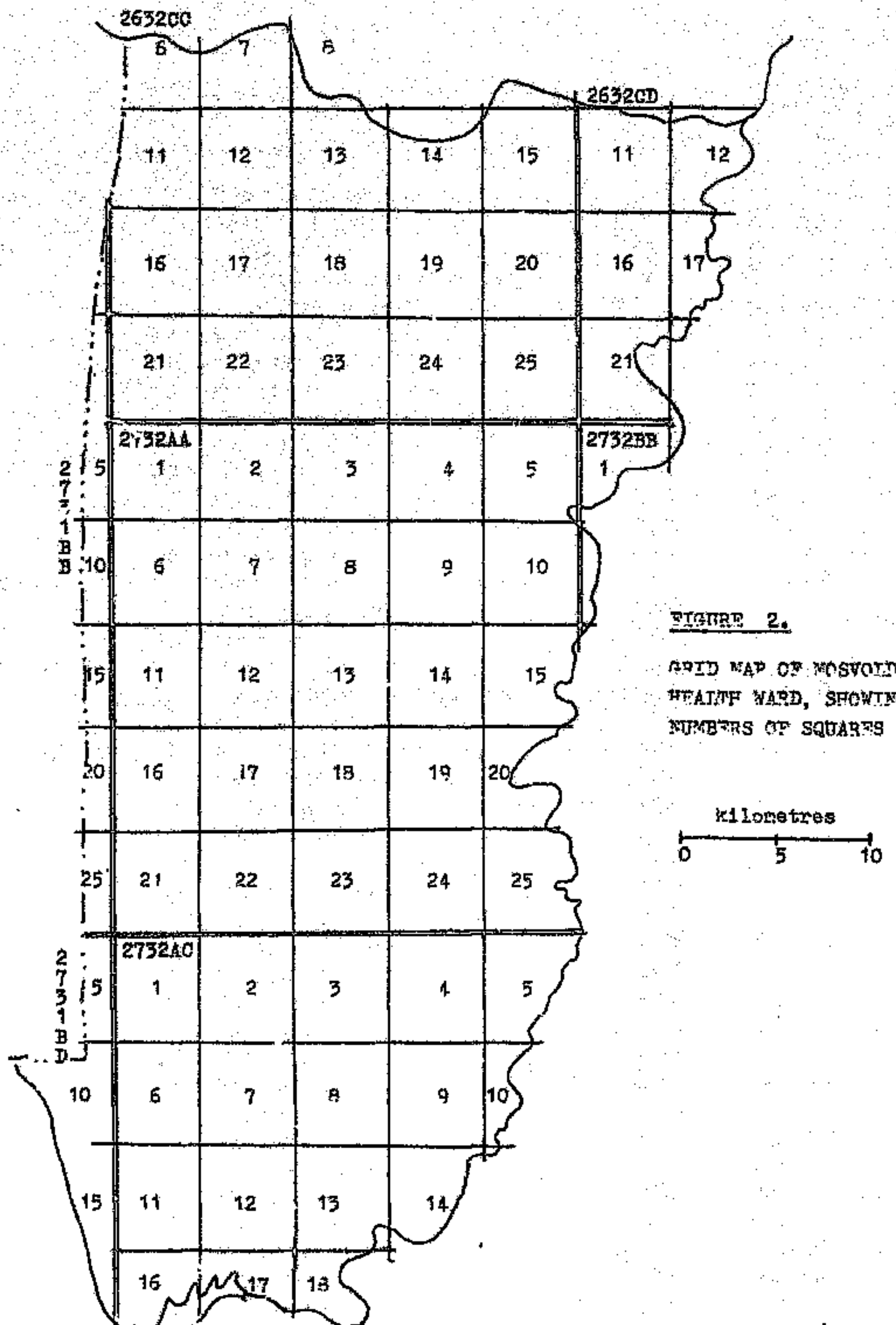

FIGURE 2.

GRID MAP OF MOSVOLD HEALTH WARD, SHOWING NUMBERS OF SQUARES

TABLE 2: LIST OF SQUARES WITH ESTIMATED POPULATION AND ALLOCATED NUMBERS

Square No.		Name	Population	Numbers
2632 CC	7	Ekuhlehleni	320	1
	11	Ekuhlehleni	1157	2,3
	12	Mabona	365	4
	14	Ndumu Game Reserve	401	5
	16	KwaMankenke*	2501	6,7,8,9
	17	Khume	561	10
	18	Magwangu	507	11
	19	Maysie	481	12
	20	Msunduze	952	13,14
	21	Ngonyameni*	1353	15,16
	22	Ebovini*	463	17
	23	Embadleni School	863	18
	24	Embadleni*	472	19
	25	Manyiseni	1451	20,21
2632 CD	16	Ndumu	943	21,22
	17	Thelamama*	659	23
	21	Namaneni*	881	24
2731 BB	15	Ingwavuma**	566	25,26,27
	20	Isihlangwini-West*	1086	28,29
	25	Mthonjeni	570	30
2732 AA	1	Nkungwini*	1308	31,32
	2	Oshabeni*	507	33
	3	Mkhayeni*	641	34
	4	Nkwambane	650	35
	5	Shemula Gate*	774	36
	6	Mack's Pass	320	37
	7	Ludwaleni*	579	38
	8	Nonjinjikazi*	1148	39,40
	9	Mngomezulu	605	41
	10	Shemula	694	42
	11	Magugu*	2403	43,44,45,46
	12	Mbuzini	774	47
	13	Njobeni	1326	48,49
	14	Siweni	614	50
	15	Kumaleni*	926	51,52
	16	Sihlangwini	837	53
	17	Mgqwembe	757	54
	18	Nyamane	543	55
	19	Mlambongwenya	1041	56,57
	20	Thombothi	935	58,59
	21	Mfithi*	1050	60,61
	22	Lubambo*	650	62
	23	Lubambo**	917	63,64

TABLE 2: LIST OF SQUARES WITH ESTIMATED POPULATION AND ALLOCATED NUMBERS (Continued)

Square No.		Name	Population	Numbers
2732 AA	24	Mzinyeni-West	1130	65,66
	25	Mzinyeni	1273	67,68
2732 AB	1	Sokhunti*	472	69
2731 BD	5	Mombeni*	1362	70,71
	10	Gwaliweni	623	72
	15	Mfutweni	481	73
2732 AC	1	Gwaliweni*	1460	74,75
	2	Ophondweni	952	76,77
	3	Mpontshane*	1024	78,79
	4	Mangqwasha**	1575	80,81,82
	5	KwaMandundu*	1371	83,84
	6	Lumbe	1121	85,86
	7	Ophondweni-South	1164	87,88
	8	Nondabuya*	`70	89
	9	Mfingosi	917	90,91
	10	Nhlanzana	579	92
	11	Bhokweni*	694	93
	12	Menyuka	1255	94,95
	13	Ohlalwini	1593	96,97,98
	14	Makatini	561	99
	16	Mpondwane	383	100
	17	Jozini	445	101
	18	Othobothini	418	102

* Squares chosen to provide one cluster to the sample

** Squares chosen to provide two clusters to the sample

b. <u>Selection of starting points for each cluster</u>

Clusters were represented by squares. An ideal random starting point for each square would be the geographical centre-point, which is obtained by drawing two diagonals through the square. We found, however, that this point was in many cases inaccessible, and not at all representative of the square in terms of population density. The use of this method would introduce bias towards isolated, relatively poorly populated areas. The EPI recommendation of choosing a starting point in a village could clearly not be used in the absence of discrete settlements. We decided, therefore, to modify the centre-point method to take into account population distribution, by using the road nearest to the centre-point as a reference, since roads are generally situated in settlements. The point on the road or track (accessible by four-wheel drive vehicle) nearest to the centre-point of the square would be approached from the hospital. Upon reaching this point, the observers would continue driving for exactly 1,0 kilometre in the same direction. The first homestead seen from the road after 1,0 kilometre from the reference point was designated as the starting point for the square. Where two clusters were chosen in one square, the observers, returning from the first cluster chosen as described above, would pass the reference point and continue for exactly one kilometre towards the hospital and the first homestead seen after that would be designated the second starting point for the square. Starting point selection is illustrated for a hypothetical square in Figure 3.

Conveniently, the KwaZulu government provides aerial photographs (ortho-photo maps) of scale 1:10 000. Each map measures three minutes latitude by three minutes longitude, and therefore, corresponds exactly to a square used in this method. Tracks, roads and shops, schools and large homesteads could be easily distinguished on these maps and the observers could decide with some reasonable accuracy when they had reached the reference point.

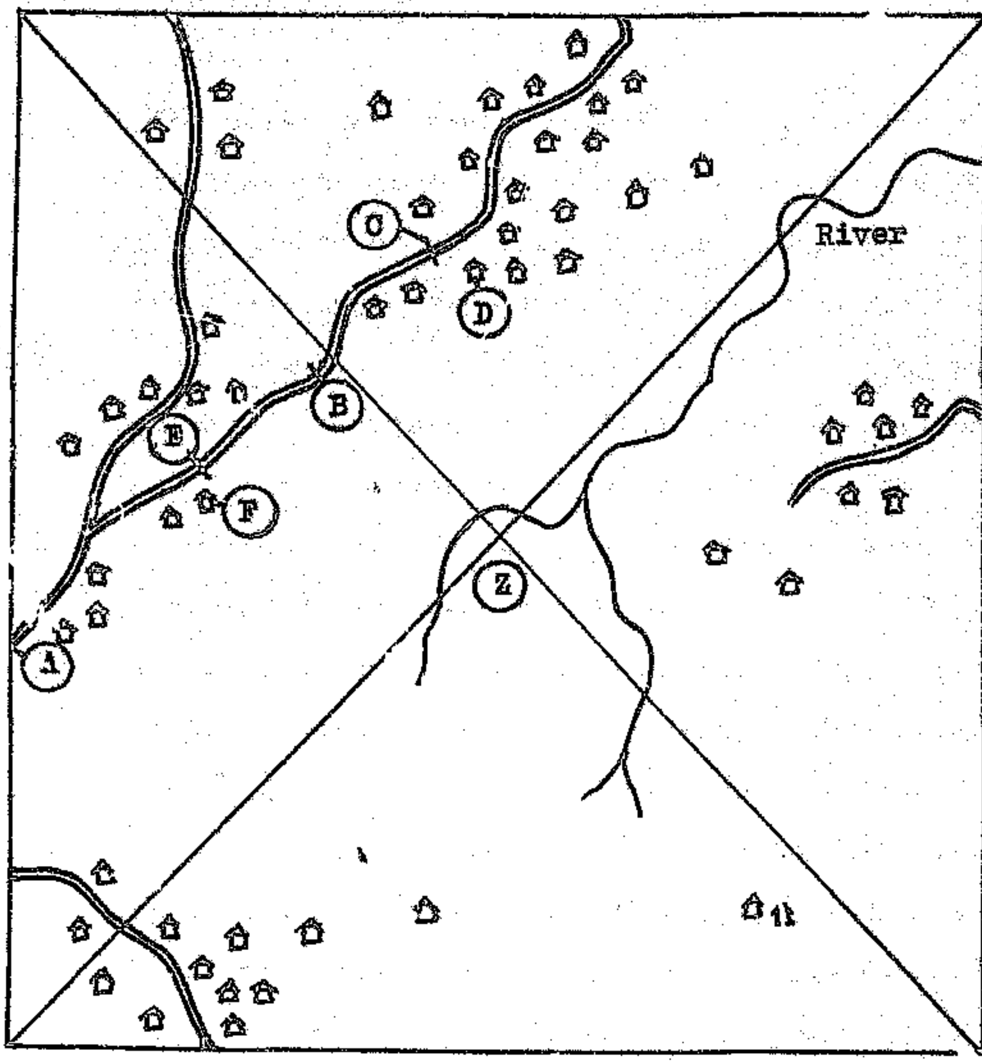

Figure 3. Hypothetical 3' X 3' square showing roads, homesteads and the centre of the square Z. The observers enter the square at A and reach reference point B, closest to the centre. They continue for exactly one kilometre to reach point C. The first homestead encountered after that is D, the starting point for the cluster. If a second cluster needs to be visited, the observers drive back to B and continue for one kilometre to reach point E. F will be the starting homestead.

c. <u>Data collection</u>

The observers were two trained nurses drawn from the hospital community health team. Upon entering the starting homestead, they enquired if any children aged 12 to 23 months were present. The aims and method of the study were explained to the mother or caretaker of the child (or children), and the immunisation record requested. All recorded vaccinations, with their dates, were entered on the recording sheet. The child's place of birth was asked and noted. The child was weighed using a Salter's portable baby scale, and the right mid-arm circumference measured with a cotton tape-measure. Children without immunisation records were weighed and measured, and the reason for the card's absence recorded (either that the child had never been vaccinated, or that the card was lost or unavailable). The observers then asked where they might find the next nearest neighbour, and were given directions or guided. This procedure was continued until seven eligible children had been found. Homesteads with eligible children who were not at home, were not revisited. Where homes were very sparsely distributed and seven children could not be found, the observers returned to their starting point at the road and drove on until they could see the first unvisited homestead, and continued from there until seven children were found.

d. <u>Observer training and supervision</u>

The observers were coached intensively in the use of the 1:10 000 ortho-photo maps, to ensure that they could reach their reference points easily and confidently. Squares close to the hospital were used to practise the technique before the study commenced. The author accompanied the observers on their visits to six squares during the study itself, and was satisfied the cluster identification procedure was being correctly applied.

The same observer weighed and measured all of the children and her colleague completed all the recording sheets. Both observers were fomiliar with the techniques, and their abilities were ot formally tested. During twice-weekly scale checks, however, the observers' ability to read weights correctly was beyond question.

An example of the data sheet used in the study appears in Figure 4.

e. Equipment

Hospital four-wheel drive vehicles, usually ambulances, were used. The scale was tested for accuracy using known commercial weights. On the second day of the study, it was damaged and had to be re-set. The children seen in the first three clusters had to be visited again and re-weighed. The scale was checked twice weekly and found to be accurate throughout the study. The tape-measure was tested against a ruler at the beginning and end of the study. It was accurate and had neither stretched nor shrunk.

f. Measurement of cluster distances from nearest clinics

The location of each cluster was marked on the maps. After completion of the study, the distance from each cluster starting-point to the nearest immunisation point (fixed or mobile) was measured using a measuring wheel specially designed to estimate non-linear distances on maps. The distances were measured along roads, tracks and

MOSVOLD HOSPITAL INGWAVUMA

A...ICAL..OF STUDY 1986

Nhgwini 5 km (7 km) (17).
MOSVOLD 32 km.

DATE: 86.11.03.... NAME AND NO. OF SQUARE: ..2732..AA.2.. DSHABENI

NAME OF CHILD	BIRTHDATE	BIRTHPLACE	(kg) WEIGHT	(cm) ARM	DATES OF: BCG	POLIO	POL I	POL II	POL III	DPT I	DPT II	DPT III	MEAS
THANDEKA F MSANE	25½ 26 2.85	MOSVOLD	12,3 kg	14,5cm	9.7.86	~~9.7.86~~	9.7.86 NOT	GIVEN		9.7.86	NOT	GIVEN	
SIVU..O M MNGOMEZULU	23½ 20.11.84	MOSVOLD	12,6 kg	13,5cm	20.11.84	20.11.84	NOT	GIVEN		NOT	GIVEN		
MZWAKALI M MNGOMEZULU	25 8.10.84	MOSVOLD	13kg	15,5cm	8.10.84		8.10.84	NOT	GIVEN	NOT	GIVEN		
BEAUTY F DLAMINI	19½ 15.02.85	MOSVOLD	12,2kg	16,5cm	15.2.85	15.2.85	24.4.85	10.7.85	28.6.85	24.4.85	10.7.85	28.8.85	26.7.86
SINOTHILE F MNGOMEZULU	19½ 16.2.85	Home	11,9kg	16cm	18.7.85	~~16.7.85~~	10/7/85 ~~11.9.85~~	11/9/85 NOT GIVEN		10.7.85	1.9.85	NOT	GIVEN
LUCKY M Mngomezulu	12½ 20.9.85	MOSVOLD	10kg	15cm	20.9.85	26.4.85	15.1.86	12.2.86	14.5.86	15.1.86	12.2.86	14.5.86	4.7.86
ZEBENZILE F NHAHAYE	24 4.11.84	Home	12.6kg	15.5cm	LOST		CARD						

Figure 4. Example of data sheet used during the survey.

MOSVOLD HOSPITAL INGWAVUMA

[illegible] STUDY 1986

Nhlangwini 5 km (7 km)
MOSVOLD 32 km.

(17).

DATE: 86.11.03 NAME AND NO. OF SQUARE: 2732 AA 2. DSHABENI

NAME OF CHILD	BIRTHDATE	BIRTHPLACE	(kg) WEIGHT	(cm) ARM	DATES OF: BCG	POLIO	POL I	POL II	POL III	DPT I	DPT II	DPT III	MEAS
THANDEKA F MSANE	23½ 26 2. 85	MOSVOLD	12,3 kg	14,5cm	[illegible]	~~[illegible]~~	* 9.7.86 NOT	GIVEN		* 9.7.86	NOT	GIVEN	
SIVU..O M MNGOMEZULU	23½ 20. 11. 84	MOSVOLD	12,6 kg	13,5cm	20.11.84	20.11.84	NOT	GIVEN		NOT	GIVEN		
MZWAKALI M MNGOMEZULU	25 8. 10. 84	MOSVOLD	13 kg	15,5cm	8.10.84		8.10.84	NOT		GIVEN	NOT	GIVEN	
BEAUTY F DLAMINI	19½ 15 02.85	MOSVOLD	12,2 kg	16,5cm	15.2.85	15.2.85	24.4.85	10.7.85	28.6.85	24.4.85	10.7.85	28.8.85	* 26.7.86
SINOTHILE F MNGOMEZULU	19½ 16. 2. 85	Home	11,9 kg	16cm	[illegible]	~~16.7.85~~	10/7/85 11.9.85	11/9/85 NOT GIVEN		10.7.85	1.9.85	NOT GIVEN	
LUCKY M MNGOMEZULU	12½ 20 9. 85	MOSVOLD	10 kg	15cm	[illegible]	26.9.85	15.1.86	12.2.86	14.5.86	15.1.86	12.2.86	14.5.86	4.7.86
ZEBENZILE F MAHAYE	24 4. 11. 84	Home	12.6 kg	15.5cm	LOST		CARD						

Figure 4. Example of data sheet used during the survey.

paths which appeared most suitable for reaching the nearest clinic. Linear distance "as the crow flies" has little application where mountains, cliffs, rivers and forests intervene.

CHAPTER IV RESULTS

1. Vaccination Coverage

Two hundred and ten children were sampled. The number of homesteads with absent eligible children was not quantified, but appears to have been very small, probably less than ten per cent. No caregivers refused to have their children included in the study. One hundred and sixty nine (76 per cent) of the 210 children in the sample had immunisation records. 32 (15 per cent) had never been vaccinated and 19 (9 per cent) had lost their cards. We decided to include the latter 19 in the results, in two sets of data:

1. as if none of them had had any vaccinations - a "worst" case;
2. as if all of them were fully vaccinated - a "best" case.

The timing of the vaccinations had to be taken into account. Only vaccines given before the age of 12 months were included in the results. Failure to exclude vaccinations after this age would have rendered older children in the sample more likely to have been vaccinated. Further, we excluded vaccinations performed at times when they would be expected to be ineffective. DWT and polio vaccines given before the age of six weeks, and second and third doses given less than four weeks after the previous doses, were not included.* Measles vaccinations performed at an age of less than six months also did not qualify for inclusion in the results.

The vaccination coverage rates for the sample in the "best" and "worst" cases are shown in Table 3. The EPI sampling method gives results with 95 per cent confidence limits of 10 per cent above and below the observed coverage rates.

2. Distance from Clinics

Of the 30 clusters, 13 were sited within five kilometres, ten between five and ten kilometres and seven further than ten kilometres from the nearest clinic, taking into account likely transport routes as mentioned previously. Vaccination coverage in each of

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* Polio vaccine given at birth is recognised to be of value, but is excluded from this analysis as official policy to administer this vaccine had only been implemented in the year previous to the study.

TABLE 3: PERCENTAGE OF CHILDREN VACCINATED (N = 210)

	BCG	DWT1	DWT2	DWT3	Pol1	Pol2	Pol3	Measles	Total
Best	83	77	68	56	78	68	57	56	47
Worst	74	68	59	47	69	59	48	47	38

Best = all 19 with immunisation cards lost are presumed vaccinated

Worst = all 19 with immunisation cards lost are presumed not vaccinated

Total indicates those children who had one dose each of BCG and measles, and 3 doses each of DWT and Polio vaccines

95 per cent confidence intervals are about ten per cent abovr and below the observed coverage rates

these three groups of clusters is shown in Table 4. The EPI cluster sampling method does not make provision for the disaggregation of clusters in the presentation of results, since selection within clusters is not random. Pocketing of vaccinated or unvaccinated groups of children within clusters can seriously affect the interpretation of such results. From our knowledge of the study population, however, it seems unlikely that pocketing would have occurred, as the population is widely scattered and relatively homogeneous. For the purposes of this analysis, the assumption is made, with a little reserve, that the 30 X 7 sample in our area has similar characteristics to a simple random sample. If this assumption is correct, the relationship between distance from clinics and vaccination coverage can be examined. Using the Chi-square test, statistically significant differences in coverage were found between those children living near, and those far from clinics, for all three doses of DWT (I: P = 0,025; II: P = 0,005; III: P = 0,005) and for the second and third doses of polio vaccine (II: P = 0,005; III: P = 0,005). Differences in measles vaccination coverage rates were not statistically significant when the study sample was grouped as in Table 4 (P = 0,10). However, if the proportion of children living within five kilometres of a clinic vaccinated against measles was compared

TABLE 4: NUMBER OF CHILDREN VACCINATED AS A FUNCTION OF DISTANCE OF HOMESTEAD FROM THE NEAREST CLINIC (N = 191*) Percentage Coverages are given in brackets.

Distance from clinic (km)	Total	BCG no.	BCG %	DWT1 no.	DWT1 %	DWT2 no.	DWT2 %	DWT3 no.	DWT3 %	Pol1 no.	Pol1 %	Pol2 no.	Pol2 %	Pol3 no.	Pol3 %	Measles no.	Measles %
0-5	82	66	80	66	80	64	78	54	66	66	80	64	78	55	67	49	60
6-10	62	54	87	48	77	38	61	31	50	49	79	38	61	31	50	31	50
>10	47	36	77	28	60	21	45	14	30	29	62	21	45	14	30	18	38
X^2		1,6		7,4		15,4		14,5		5,4		15,4		17,5		5,5	
P		0,5		0,025		0,005		0,005		0,10		0,005		0,005		0,10	

* Children with lost immunisation cards were excluded from this analysis

with those living further than five kilometres from a clinic, the difference was statistically significant (P = 0,03).

It should be emphasised again that the significance of these findings is based on an untested assumption, and provide little more than a suggestion or trend towards decreasing vaccination coverage with increasing distance from clinics.

3. Birthplace

The birthplaces of the children in the sample is shown in Table 5.

4. Birthplace and Vaccination Coverage

Vaccination coverage rates of children b at home "unsupervised", and at hospital clinics ("supervised") are shown in Table 6. Again, the assumption is made that the 30 X 7 sample has the same characteristics in our area as a simple random sample. Statistical significance is taken as P<0,05, after comparison of the two groups using the Chi-square test. Although coverage rates were consistently better for those born in hospital or clinic, the only significant differences between the two groups were found with BCG and the second dose of DWT and Polio vaccines. The drop-out rate from the first to the second dose of DWT and polio vaccines was much higher among the children born at home.

TABLE 5: BIRTHPLACES OF CHILDREN IN THE SAMPLE (N = 210)

Place	Number	Percentage
Home	101	48
Mosvold Hospital	81	39
Mosvold clinics	5	2
Other health institutions	23	11
Total	210	100

5. Weights

The observers rounded off 94 per cent of the weight readings to the nearest half-kilogram, even though the scale was accurate to 0,1 kilogram. Using NCHS percentile charts for weight-for-age, all weights were translated into percentiles.[112,113] The results are shown in Figure 5. The mean percentile weight-for-age

TABLE 6: NUMBER OF CHILDREN VACCINATED AS A FUNCTION OF SUPERVISED OR UNSUPERVISED BIRTH (N = 191*)

Delivery-place		Number of children having received															
	Total	BCG no.	%	DWT1 no.	%	DWT2 no.	%	DWT3 no.	%	Pol1 no.	%	Pol2 no.	%	Pol3 no.	%	Measles no.	%
1.	97	88	91	78	80	73	75	56	58	78	80	73	75	57	59	57	59
2.	94	68	72	64	68	50	53	43	46	66	70	50	53	43	46	41	44
χ^2		9,4		3,2		9,2		2,3		2,2		9,2		2,7		3,8	
P		0,002		0,07		0,002		0,13		0,14		0,002		0,10		0,051	

1.= Supervised delivery
2.= Unsupervised delivery
* Children allegedly vaccinated but whose cards were lost, are excluded from this analysis

TABLE 6: NUMBER OF CHILDREN VACCINATED AS A FUNCTION OF SUPERVISED OR UNSUPERVISED BIRTH (N = 191*)

Delivery-place	Number of children having received																
	Total	BCG no.	%	DWT1 no.	%	DWT2 no.	%	DWT3 no.	%	Pol1 no.	%	Pol2 no.	%	Pol3 no.	%	Measles no.	%
1.	97	88	91	78	80	73	75	56	58	78	80	73	75	57	59	57	59
2.	94	68	72	64	68	50	53	43	46	66	70	50	53	43	46	41	44
X^2		9,4		3,2		9,2		2,3		2,2		9,2		2,7		3,8	
P		0,002		0,07		0,002		0,13		0,14		0,002		0,10		0,051	

1.= Supervised delivery
2.= Unsupervised delivery
* Children allegedly vaccinated but whose ca ds were lost, are excluded from this analysis

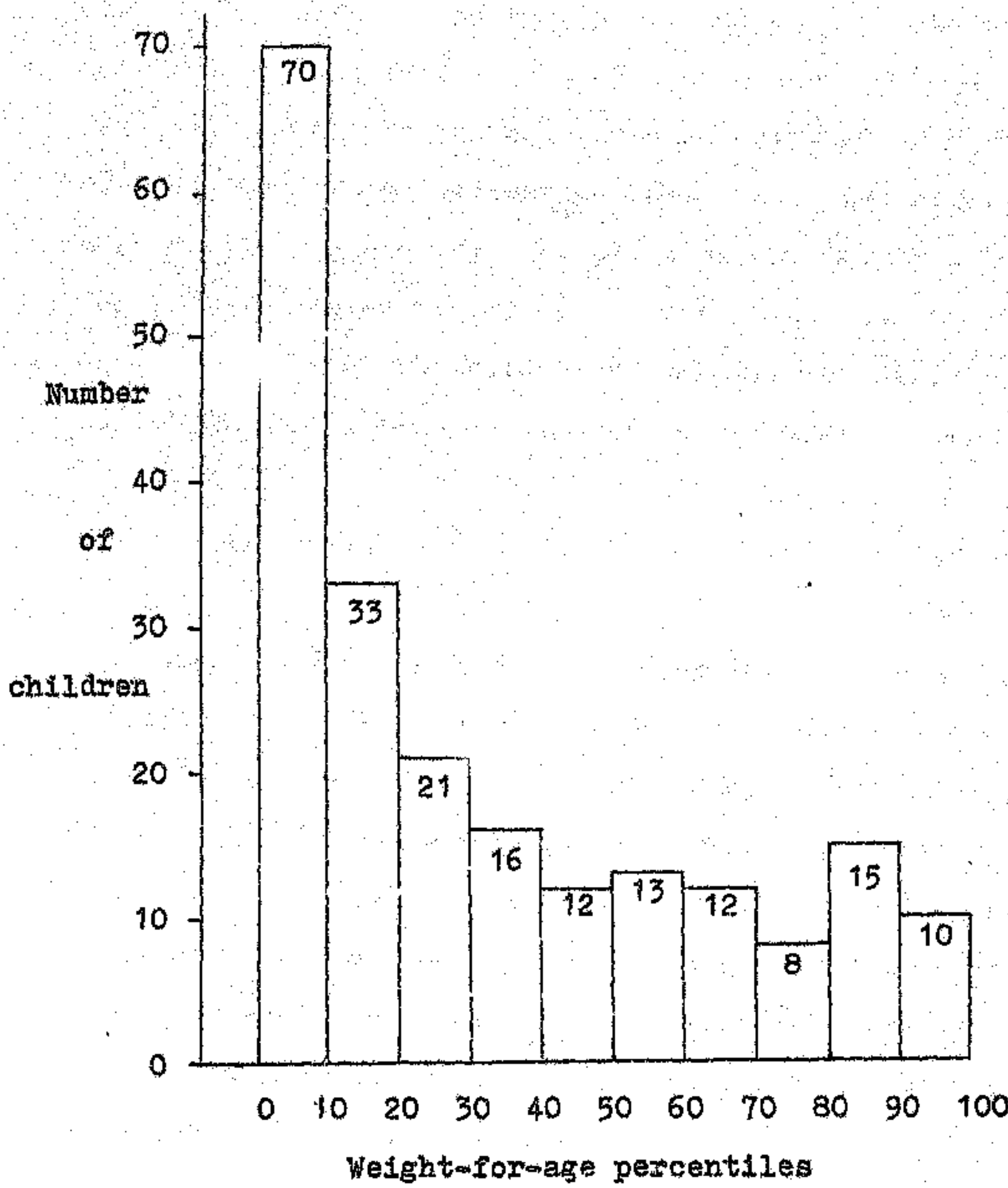

Figure 5. Histogram showing weights of children according to weight-for-age percentiles (N = 210).

was 32,3, with a standard deviation of 29. The mean percentile eight-for age of children born at home was 28,4 and that of children born in hospital or clinic was 36,0. This difference was not statistically significant (Student's t-test, t =1,88; 0,05<P<0,10). Thirty-two children (15 per cent) had weights which were more than two standard deviations below the median weight-for-age obtained from the NCHS curves.

6. Arm Circumference

The mean value was 15,5 centimetres. Twenty-four children (11 per cent) had an arm circumference of 13,5 centimetres or less; of these, 3 (1,4 per cent of the total) had measurements of 12,5 centimetres or less. Again, the observers rounded off their readings, to the nearest half centimetre. A mid upper arm circumference of 12,5 cm or less indicates severe chronic malnutrition, and between 12,5 and 13,5 cm, moderate chronic malnutrition.[114]

CHAPTER V: CONCLUSIONS

1. Methodology

The EPI sample method was easily applied using the modification based on squares from the grid map. It provided a repeatable, relatively reliable technique for obtaining vaccination coverage data. A dilemma still exists regarding those children allegedly immunised but whose cards are lost. We chose to include them in the sample and give a "best" and a "worst" analysis as described above. This effectively widened the range of 95 per cent confidence limits to make the results appear somewhat inaccurate. Alternative methods, where such children are excluded from the sample or where they are simply labelled unvaccinated, make the results more presentable, but come no closer to the truth and could even be considered dishonest. In line with the EPI sampling technique, we excluded children who were not at home on the day of the observers' visit. We cannot tell if these children differed from our sample in their vaccination status. Such "missing" children were certainly the exception in this study: more frequently, the mothers were away, leaving their children with caretakers who assisted our observers with the vaccination cards.

The data on weights and arm circumferences were unfortunately not as precise as we may have liked. The tendency of the observers to round off to the nearest 500 grams and five millimetres respectively not foreseen and was only detected once the study well under way. Preparation for this part of the survey was clearly not adequate. It must be stated here that the author was at the time of the study employed as the medical superintendent of Mosvold Hospital, and had important administration and clinical responsibilities to fulfill. Formal checks for intra-observer repeatability were not done, although time was spent with the observers checking the scale periodically, and their ability to read off weights accurately was beyond doubt. In the hope that the approximations of readings cancel themselves out eventually, we feel that the figures obtained still provide a useful basis for future nutritional research and give reasonable baseline data on undernutrition. This was the first study of its kind undertaken at Mosvold Hospital, and valuable lessons have been learned.

2. Discussion of Results

a. Vaccination coverage

Overall vaccination coverage was low, comparing with some of the poorer countries of sub-Saharan Africa (see Table 1). Coverage rates were lower with the later vaccines, and measles vaccination, given at nine months, had the lowest coverage, even though the disease is the most common and severe of the EPI target diseases at Mosvold Hospital.

The EPI sampling technique does not allow accurate estimation of vaccination status of subgroups in the total sample, but our data suggests that the children living further than five kilometres from a clinic had relatively worse vaccination status than those living within a five kilometre range of a clinic. The coverage was particularly poor among those living more than ten kilometres from a clinic. Distance from clinic appears to play a major role in the motivation of mothers to have their children vaccinated. This is quite understandable in an area such as ours, where people move mainly on foot and public transport is scarce and relatively expensive. The first doses of DPT and Polio vaccines were an exception, however, with no significant differences between those children living near to, and those far from clinics. Perhaps the mothers' initial wave of enthusiasm following their recent childbirths provided a high motivation to have their children vaccinated; they may have thought that the one dose of vaccine provided sufficient protection and that in view of the long distance to the clinic, further doses were not worth the additional effort.

Drop-out rates from the first to the third doses of DWT and poliomyelitis vaccines were high. In the overall study sample, between 28 per cent and 31 per cent of children who received a first dose did not receive the third dose. This drop-out rate was highest in those living further than ten kilometres from a clinic, where only 48 per cent to 50 per cent of those receiving a first dose eventually received the third dose.

The effect of home delivery on vaccination coverage was not striking. Our figures suggest that children born at home have relatively poorer vaccination status and higher drop-out rates than those born in hospital or clinics. The reasons for this are not clear; mothers may be encouraged in the postnatal ward to come back to have their children vaccinated. Some mothers who give birth at home may, through ignorance or suspicion, prefer to avoid contact with the health services; others with multiple family commitments may not have the time to stay in hospital for delivery, nor to take their children to clinics for vaccination. The statistical basis for these findings was, however, of doubtful value, in view of the disaggregation of the clusters for analysis.

In our survey, no attempt was made to find reasons for poor vaccination status, with the exception of distance from clinic and home delivery. From the available literature and our own experience, we suggest other possible reasons:

1. Scarce resources A shortage of staffing and vehicles has prevented the establishment of immunisation services within five kilometres of each home. The KwaZulu department of Health is severely affected by a shortage of funds, and immunisation must compete with other health priorities for a share of the available resources.

2. <u>Ignorance</u> Most adults in the area are illiterate and rely on the spoken word for information. It is possible that many parents do not believe that vaccination really prevents disease. Some may suspect that vaccinations may harm their children.

3. <u>Migrant labour</u> Many able-bodied adults leave their families to work on distant mines, industries and farms. Those left behind have greatly increased family responsibilities, just one of which is to ensure vaccinations for their children. There may simply be no time to take their children to clinics, especially if this means a long walk and a whole day wasted. Mothers, themselves, may join the migrant labour market and leave their small children in the care of older siblings or grandparents, who might not understand the importance of immunisation.

4. <u>Missed vaccination opportunities</u> Children who present at clinics with minor illnesses do not always have their health cards checked for evidence of vaccination. Some children only see health workers in times of sickness, and these opportunities to administer vaccines and

inform parents are frequently missed.

5. Staff training None of the nursing staff who provide vaccinations have had any special training in immunisation. The dates of vaccinations are well known, but there is relatively little knowledge about side-effects, efficacy and contraindications. Many staff members feel uneasy about vaccinating ill children, for example. Health talks presented in lecture form to groups of mothers in clinics do not always contain correct information.

b. Recommendations for improving vaccination coverage

1. Immunisation Officer A member of the hospital staff with experience of managing rural primary health care should be appointed as "immunisation officer" for the Health Ward, to co-ordinate local policy on vaccines, to train and supervise staff, and to assess immunisation priorities including coverage studies and surveillance of target diseases. This action does not mean that immunisation is offered as a separate selective service; it intends only to strengthen this very important

arm of an integrated primary health care approach which also includes nutrition, oral rehydration and family spacing objectives. Such an approach would be in line with recent published recommendations.[22,77]

2. Staff Training There is a need for formal in-service training of primary health care staff in all aspects of immunisation. Health education techniques should be adapted to be more appropriate to local conditions and customs. A friendly and caring attitude to patients should also b ongly encouraged.

3. Expansion of clinic services There is an urgent need for more clinics in the Health Ward. Many, if not most people, live further than five kilometres from the nearest clinics. The immediate priority is the establishment of mobile under-five clinics to cover the entire Health Ward so that all homes are within five kilometres of an immunisation point (or clinic). Such a service should c mmence with a highly publicised and carefully planned mass immunisation campaign, with maximum community articipation. The intentions and methods should be fully

discussed with community representatives in each area, and their help sought in the choice of appropriate sites and structures where the clinics can be held. Community awareness should be brought to a level where the momentum g ined during the mass campaign will not ea ily dissipate, and the cli..ics become viable routine services and a regular feature of community life. Well functioning under-five clinics will lead to demands from the community for comprehensive mobile clinics and later fixed clinics, if warranted by the work-load. As aspirations are realised, demands may follow for better water supplies, perhaps schools and roads. In this way, immunisation can be the leading edge for social mobilisation across a broad front of basic needs.

<u>Missed vaccination opportunities</u> Clinic staff should use every opportunity to vaccinate eligible children. Ill children presenting on "non-vaccination days" should be given vaccine, even if a multiple-dose vial must be opened for only one child. The identification of eligible children has been facilitated by the KwaZulu child health card,

on which weights, vaccinations <u>and</u> illnesses are recorded. There are no separate Road-to-Health and "illness" cards; mothers who bring their children for illness are then unlikely to forget a vacc ıa: ın card at home.

5. <u>A new vaccination schedule</u> Consideration should be given to changing the immunisation schedule for the first three doses of DWT and polio vaccines. These can be completed by 14 weeks of age instead of the customary six months.[97] Mothers are likely to find it easier to bring their children to clinics when they are still very young and easier to carry.

6. <u>Community Health Workers</u> Lay community health workers are now being trained in the Health Ward. The community health worker programm aims to bring health promotion into every home. Each community health worker will serve an area of 100 to 150 homesteads, and will be able to provide effective health education if properly trained and motivated. The importance of immunisation must be emphasised as a priority in their training programmes.

7. Traditional doctors Inyangas are widely respected and consulted by the people. The support of inyangas in the immunisation programme may be invaluable and could be solicited by holding meetings and discussing illness and immunisation.

8. The mass media Radio Zulu should be more involved in the broadcasting of immunisation messages. For many, this will be the only way of hearing objective information about immunisation.

c. Home delivery

Our suspicion that the incidence of home delivery was high, has been confirmed. There is thus a place for further research into home deliveries, particularly regarding methods of childbirth, perinatal morbidity and mortality, and the role of traditional birth attendants (TBA's). Larsen has described the importance of TBA's in home births in southern KwaZulu and the part they play in good obstetric care.[118,116] Whether a similar situation exists in the Mosvold area is not clear to us at present.

d. Weights

Weight-for-age assessment of nutritional status is widely used and reflects both stunting of growth and consequently long-term undernutrition, as well as current undernutrition. It is useful for monitoring nutritional status of individual children and communities. Low height-for-age is an indicator of chronic undernutrition or illness, since birth, while low weight-for-height provides evidence of current, or acute undernutrition or illness.[117] We did not m[illegible]e heights in this study and so can only rely on the composite indicator of chronic and acute malnutrition provided by the weight-for-age data.

Children of low weight-for-age appear to be at greater risk of developing severe forms of infections such as measles and gastroenteritis.[118,119] Weight-for-age data are considered by the WHO to be among the most important indicators of child health in communities.[117] The measurement of numbers of underweight children therefore contributes to an understanding of local child health conditions. The WHO defines as underweight those children whose weights are more than two standard deviations below the median obtained from NCHS weight-for-age curves.

In our sample, 15 per cent of the children were underweight. This is similar to most figures from studies on black children in South Africa. See Table 7.

TABLE 7: RESULTS FROM RECENT STUDIES OF WEIGHT-FOR-AGE ON BLACK CHILD"°N IN THE RSA

Place, date, age-group	Percentage of children underweight
Eastern Cape (1981) Pre-school[120]	12,7 to 17,9
Vulindlela, KwaZulu (1983) Under-fives[121]	36
Urban areas, Transvaal (1977) one to twos[122]	15,5
R.S.A. excluding homelands (1987) one to twos[123]	12,7
Cape Town (1987) one to twos[124]	10,8 to 17,5

The WHO's global goal for Health for .ll by the year 2000, concerning malnutrition, is that at least 90 per cent of children weigh not more than two standard deviations below the median weight-for-age obtained from NCHS growth curves.[117] Our study gives figures which fall a little short of the goal, at 85 per cent. This number is not as bad as might have been expected in this impoverished rural area.

e. <u>Arm circumference</u>

Mid upper arm circumference (MUAC) remains static in normal children between the ages of one and four years, and within these age limits, interpretation of measurements is not dependent on an exact knowledge of age. A MUAC of 12,5 centimetres or less indicates severe chronic malnutrition and between 12,5 and 13,5 centimetres indicates moderate chronic malnutrition.[114] MUAC correlates closely with weight-for-height or "thinness".[128] There is some evidence that single measurements of arm circumference are more reliable in predicting children nutritionally at risk, and at risk of dying than other methods of anthropometric measurement.[126,127] A problem with MUAC is that accuracy of measurement is vitally important, since only small inaccuracies may result in large errors in classification.[117,127]

In our sample, only 1,4 per cent of children could be regarded as severely malnourished, with 10 per cent moderately malnourished. Of the 24 children with MUAC of 13,5 cm or less, 18 had weights less than two standard deviations below the NCHS norm.

Discussion of the causes and remedies of community undernutrition falls beyond the scope of this paper. Specific actions taken at Mosvold Hospital include health and nutrition education of mothers at under-five clinics, and a nutrition rehabilitation unit where mothers of the severely malnourished undergo child nutrition instruction. The unit is staffed by two nurses trained in nutrition education at the Valley Trust near Durban. Food supplements are not given; the emphasis of the unit is on self-reliance and effective use of available foods.

We are hoping that the planned establishment of mobile under-five clinics in the Health Ward will bring more information to mothers as well as provide weighing facilities. Community health workers presently in training will be able to carry nutrition information and advice into peoples' homes, and will refer severely malnourished children to clinic before they become gravely ill.

The causes of malnutrition are deeply rooted in social, economic and political realities, and largely beyond the control of health workers. The vicious cycle of poverty, underdevelopment and exploitation needs to be broken before progress towards "health for all" can surge forward.

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APPENDIX

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

COMMITTEE FOR RESEARCH ON HUMAN SUBJECTS (MEDICAL)
Ref: R14/49 (Registry)

CLEARANCE CERTIFICATE PROTOCOL NO: 05/8/91

PROJECT: VACCINATION COVERAGE, WEIGHTS AND BIRTHPLACES OF CHILDREN AGED 12 TO 23 MONTHS IN THE MOSVOLD HEALTH WARD OF KWAZULU

INVESTIGATORS: DR EJ BUCHMANN

DEPARTMENT: COMMUNITY HEALTH, MEDICAL SCHOOL

DATE CONSIDERED: 30 AUGUST 1991

RECOMMENDATION OF THE COMMITTEE: APPROVED

in retrospect.

Date: 4 SEPTEMBER 1991 Chairman:..................
Prof P E Cleaton-Jones

* Guidelines for written "Informed Consent" attached where applicable.

DECLARATION OF INVESTIGATOR/S

To be completed in duplicate and ONE copy returned to Miss S M Boshoff at Room 10-002, 10th Floor, Senate House, University.

I/we fully understand the conditions under which I am/we are authorised to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Date: 1/10/91............ Signature:..................

APPENDIX

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

FACULTY OF MEDICINE

APPLICATION FOR PERMISSION TO PERFORM RESEARCH AT AN INSTITUTION OUTSIDE THE UNIVERSITY AND ITS ASSOCIATED INSTITUTIONS

NAME OF APPLICANT : Dr E J Buchmann

QUALIFICATIONS : M.B.,B.Ch.

APPLICANT FOR DEGREE OF : M.Sc. (Med)

DEPARTMENT/INSTITUTION at which research is to be undertaken :

Department of Community Health

PLACE/S at which experiments/collection of data is to be done :

Mosvold Hospital, Ingwavuma, KwaZulu.

PROPOSED LINE OF RESEARCH : Vaccination status, weights and home deliveries in the Mosvold Health Ward, KwaZulu, among children aged 12 to 23 months.

BRIEF OUTLINE OF PROPOSED LINE OF RESEARCH : Using a cluster sample technique, home visits are undertaken where children are weighed, their immunisation cards inspected and the place of birth asked. The results are analysed.

Signature of Head of Department/Institution approving the research project:

Med. Supt.

Date 18/10/88.

Official Stamp

MOSVOLD HOSPITAL
P.O. INGWAVUMA
3968
1988 -10- 1
UMNYANGO WEZEMPILO
DEPARTMENT OF HEALTH

Signature of Applicant :

Date : 18/10/88

TWS/jh 24 May 1988 FO3PG